Title IIB Massachusetts Math and Science Partnership
Project Evaluation Report of Findings

Name of Partnership	**Collaborating to Create a Science Learning Community**
Reporting Period	**September 2010-August 2012**
Date of Report Submission	**10/5/2012**

Individuals Contributing to the Completion of This Report			
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Courses Offered: January 2011-August 2012	
Course Name	**Course Focus** *("Math" or "Science/Technology" or "Blended Math and Science/Technology")*
Earth Science: Weather and Water	Science/technology
Biology: Ecology, Evolution, and Diversity of Life	Science/technology
Physics: Electricity and Magnetism	Science/technology
Biology: Cell Biology and Genetics	Science/technology

Earth Science: Weather and Water
Winter/Spring 2012

Please indicate what type of supplemental activity[1] your partnership offered:

__X__ Professional Learning Communities

__X_ Lesson Study

__X__ Curriculum Alignment and/or Mapping Project

_____ Participant Portfolios

__X__ Participant Project

_____ Leadership Training (for coaches/instructional leaders)

___X_ Online work
Specify details here: Online and face-to-face workshops were designed to supplement course activities to assist teachers in creating classroom lessons incorporating course content.

_____ Other
Specify details here:

Description of Supplemental Activity:
32 hours of supplemental activities designed to assist participating teachers in creating classroom lessons incorporating the *Earth Science: Weather and Water* content and inquiry-based learning experiences for students. These activities included a two-hour orientation before the course, eight hours during the course, and each participant was required to complete an additional 22 hours by June 12, 2012. Each participating teacher was required to successfully complete the activities within each workshop to move forward to the next workshop. All face-to-face and online supplemental activities were facilitated by the district-based Teacher Learning Center Directors (TLCD's) and the course faculty. All teachers, TLCD's and the project evaluator signed individual participation checklists to confirm supplemental activity participation and course evaluation activities were complete prior to the award of supplemental activity stipends.

Start date of Supplemental Activity: January 10, 2012
End date of Supplemental Activity: June 12, 2012

Was this supplemental activity related to an MMSP course? Yes

If this supplemental activity was related to an MMSP course, please provide name of the course to which it was related: Earth Science: Weather and Water

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[1] Throughout the report "supplemental activities" are also referred to as "follow-up activities."

Was this supplemental activity related to a school or district initiative? Yes

If this supplemental activity was related to a school or district initiative, please indicate to which initiative the activity was related: All courses were aligned with district technology plans, identified teacher professional development needs and school improvement plans.

How many individuals participated in this supplemental activity?   23

Of the total number of individuals who participated in this supplemental activity, how many had also already participated in an MMSP course?   23

How many contact hours did the supplemental activity require of each participant? 24 hours

How many additional/non-contact hours did the supplemental activity require of each participant? ("Additional/non-contact hours" refers to things like lesson preparation, formative assessment, data analysis, etc.) 8 hours of course-related inquiry-based activity development assigned by the course instructor which serves as the preliminary lesson activities for the supplemental workshops

Biology: **Ecology, Evolution, and Diversity of Life**
Summer 2012

Please indicate what type of supplemental activity your partnership offered:

__X__ Professional Learning Communities

__X_ Lesson Study

__X__ Curriculum Alignment and/or Mapping Project

_____ Participant Portfolios

__X__ Participant Project

_____ Leadership Training (for coaches/instructional leaders)

___X_ Online work
Specify details here: Online and face-to-face workshops were designed to supplement course activities to assist teachers in creating classroom lessons incorporating course content.

_____ Other
Specify details here:

Description of Supplemental Activity:
32 hours of supplemental activities designed to assist participating teachers in creating classroom lessons incorporating the *Biology: Ecology, Evolution and Diversity of Life* content and inquiry-based learning experiences for students. These activities included a two-hour orientation before the course, eight hours during the course, and each participant was required to complete an additional 22 hours by August 10, 2012. Each participating teacher was required to successfully

complete the activities within each workshop to move forward to the next workshop. All face-to-face and online supplemental activities were facilitated by the district-based Teacher Learning Center Directors (TLCD's) and the course faculty. All teachers, TLCD's and the project evaluator signed individual participation checklists to confirm supplemental activity participation and course evaluation activities were complete prior to the award of supplemental activity stipends.

Start date of Supplemental Activity: June 13, 2012
End date of Supplemental Activity: August 10, 2012

Was this supplemental activity related to an MMSP course? Yes

If this supplemental activity was related to an MMSP course, please provide name of the course to which it was related: Biology: Ecology, Evolution, and Diversity of Life

Was this supplemental activity related to a school or district initiative? Yes

If this supplemental activity was related to a school or district initiative, please indicate to which initiative the activity was related: All courses were aligned with district technology plans, identified teacher professional development needs and school improvement plans.

How many individuals participated in this supplemental activity? 17

Of the total number of individuals who participated in this supplemental activity, how many had also already participated in an MMSP course? 17

How many contact hours did the supplemental activity require of each participant? 24 hours

How many additional/non-contact hours did the supplemental activity require of each participant? ("Additional/non-contact hours" refers to things like lesson preparation, formative assessment, data analysis, etc.) 8 hours of course-related inquiry-based activity development assigned by the course instructor which serves as the preliminary lesson activities for the supplemental workshops

Physics: **Electricity and Magnetism**
Winter/Spring 2011

Please indicate what type of supplemental activity your partnership offered:

__X__ Professional Learning Communities

__X_ Lesson Study

__X__ Curriculum Alignment and/or Mapping Project

_____ Participant Portfolios

__X__ Participant Project

_____ Leadership Training (for coaches/instructional leaders)

___X_ Online work
Specify details here: Online and face-to-face workshops were designed to supplement course activities to assist teachers in creating classroom lessons incorporating course content.

_____ Other
Specify details here:

Description of Supplemental Activity:
32 hours of supplemental activities designed to assist participating teachers in creating classroom lessons incorporating the *Physics: Electricity and Magnetism* content and inquiry-based learning experiences for students. These activities included a two-hour orientation before the course, eight hours during the course, and each participant was required to complete an additional 22 hours by August 2011. Each participating teacher was required to successfully complete the activities within each workshop to move forward to the next workshop. All face-to-face and online supplemental activities were facilitated by the district-based Teacher Learning Center Directors (TLCD's) and the course faculty. All teachers, TLCD's and the project evaluator signed individual participation checklists to confirm supplemental activity participation and course evaluation activities were complete prior to the award of supplemental activity stipends.

Start date of Supplemental Activity: June 2011
End date of Supplemental Activity: August 2011

Was this supplemental activity related to an MMSP course? Yes

If this supplemental activity was related to an MMSP course, please provide name of the course to which it was related: Physics: Electricity and Magnetism

Was this supplemental activity related to a school or district initiative? Yes

If this supplemental activity was related to a school or district initiative, please indicate to which initiative the activity was related: All courses were aligned with district technology plans, identified teacher professional development needs and school improvement plans.

How many individuals participated in this supplemental activity? 18

Of the total number of individuals who participated in this supplemental activity, how many had also already participated in an MMSP course? 18

How many contact hours did the supplemental activity require of each participant? 24 hours

How many additional/non-contact hours did the supplemental activity require of each participant? ("Additional/non-contact hours" refers to things like lesson preparation, formative assessment, data analysis, etc.) 8 hours of course-related inquiry-based activity development

assigned by the course instructor which serves as the preliminary lesson activities for the supplemental workshops

Biology: **Cell Biology and Genetics**
Summer 2011

Please indicate what type of supplemental activity your partnership offered:

__X__ Professional Learning Communities

__X_ Lesson Study

__X__ Curriculum Alignment and/or Mapping Project

_____ Participant Portfolios

__X__ Participant Project

_____ Leadership Training (for coaches/instructional leaders)

___X_ Online work
Specify details here: Online and face-to-face workshops were designed to supplement course activities to assist teachers in creating classroom lessons incorporating course content.

_____ Other
Specify details here:

Description of Supplemental Activity:
32 hours of supplemental activities designed to assist participating teachers in creating classroom lessons incorporating the *Biology: Cell Biology and Genetics* content and inquiry-based learning experiences for students. These activities included a two-hour orientation before the course, eight hours during the course, and each participant was required to complete an additional 22 hours by August 2011. Each participating teacher was required to successfully complete the activities within each workshop to move forward to the next workshop. All face-to-face and online supplemental activities were facilitated by the district-based Teacher Learning Center Directors (TLCD's) and the course faculty. All teachers, TLCD's and the project evaluator signed individual participation checklists to confirm supplemental activity participation and course evaluation activities were complete prior to the award of supplemental activity stipends.

Start date of Supplemental Activity: July 2011
End date of Supplemental Activity: August 2011

Was this supplemental activity related to an MMSP course? Yes

If this supplemental activity was related to an MMSP course, please provide name of the course to which it was related: Biology: Cell Biology and Genetics

Was this supplemental activity related to a school or district initiative? Yes

If this supplemental activity was related to a school or district initiative, please indicate to which initiative the activity was related: All courses were aligned with district technology plans, identified teacher professional development needs and school improvement plans.

How many individuals participated in this supplemental activity? 25

Of the total number of individuals who participated in this supplemental activity, how many had also already participated in an MMSP course? 25

How many contact hours did the supplemental activity require of each participant? 24 hours

How many additional/non-contact hours did the supplemental activity require of each participant? ("Additional/non-contact hours" refers to things like lesson preparation, formative assessment, data analysis, etc.) 8 hours of course-related inquiry-based activity development assigned by the course instructor which serves as the preliminary lesson activities for the supplemental workshops

I. Introduction

Partnership Name:	*Collaborating to Create a Science Learning Community*			
Partners: School Districts (5) Everett Public Schools (Lead Applicant) Chelsea Public Schools Malden Public Schools Medford Public Schools Wilmington Public Schools Private Schools (4) Malden Catholic High School Cheverus Centennial School Saint Clement High School Pope John XXIII High School	Other LEAs Mystic Valley Regional Charter School (MVRCS)	Collaborative (1) Tri-City Technology Education Collaborative (TRITEC)	Higher Education (1) University of Massachusetts Boston, Center for Science and Math in Context (COSMIC) University of Massachusetts Boston, School of Education	Project Evaluator (1) Dr. Diane Schilder, Evaluation Analysis, Solutions, Inc. (EAS, Inc.)
Year 2 Course Locations:	*Earth Science: Weather and Water* Malden High School, Malden, MA		*Biology: Ecology, Evolution, and Diversity of Life,* Malden High School, Malden, MA	
Year 2 Course Formats:	*Earth Science: Weather and Water* Malden High School, Malden, MA 60 hours classroom and lab coursework conducted afterschool and Saturdays + 32 hours of supplemental activities conducted face-to-face and online		*Biology: Ecology, Evolution, and Diversity of Life* Malden High School, Malden, MA 60 hours classroom and lab coursework summer institute format + 32 hours of supplemental activities conducted face-to-face and online	
Year 2 Beginning and End Course Dates: **Year 2 Supplemental Activities Dates:**	*Earth Science: Weather and Water*	January 10, 2012-June 12, 2012 June - August, 2012	*Biology: Ecology, Evolution, and Diversity of Life*	June 28 – July 12, 2012 June - August, 2012
Year 2 Number of Participants:	*Earth Science: Weather and Water*	23 participants	*Biology: Ecology, Evolution, and Diversity of Life*	18 participants
Year 1 Course Locations:	*Physics: Electricity and Magnetism* Medford High School, Medford, MA		*Biology: Cell Biology and Genetics* University of Massachusetts Boston	
Year 1 Course Formats:	*Physics: Electricity and Magnetism* Medford High School, Medford, MA 60 hours classroom and lab coursework conducted afterschool and Saturdays + 32 hours of supplemental activities conducted face-to-face and online		*Biology: Cell Biology and Genetics* University of Massachusetts Boston 60 hours classroom and lab coursework summer institute format + 32 hours of supplemental activities conducted face-to-face and online	

Partnership Name:	*Collaborating to Create a Science Learning Community*			
Year 1 Beginning and End Course Dates: **Year 1 Supplemental Activities Dates:**	*Physics: Electricity and Magnetism*	January 25 - May 24, 2011 June - August, 2011	*Biology: Cell Biology and Genetics*	July 5 - 15, 2011 July - August, 2011
Year 1 Number of Participants:	*Physics: Electricity and Magnetism*	18 participants	*Biology: Cell Biology and Genetics*	25 participants

II. Goals and Objectives

The design of the *Collaborating to Create a Science Learning Community* project is based on a successful model that TRITEC has utilized in a variety of projects. In this model, teachers come together across neighboring similar-size districts to participate in university-led, content-driven, professional development that teachers then put into practice in their respective districts through facilitated activities orchestrated by the Teacher Learning Center Directors (TLCDs). To assist teachers in translating science content and inquiry-based teaching into effective lessons for students, the TLCDs serve as mentor teacher leaders and work closely with district curriculum leaders and university faculty. This allows for customizing the content and aligning it with local district curricula and needs. The TLCDs serve as glue for the project's components, ensuring that (1) university faculty sessions meet teacher needs, (2) appropriate focus is placed on the inquiry-based teaching skills of teachers, and (3) the teachers understand how to integrate the science content into their district curriculum as evidenced through effective lesson development.

The offering of graduate science courses to multiple grade-level teachers encourages vertical curriculum alignment in this content area for the entire K-12 system, so that working in a community of learners, teachers can consider the knowledge, tools, skills, teaching practices, and assessment used to measure student learning in the grade levels *before and after* their own classrooms. For example, a teacher in 5^{th} grade may learn from their colleagues exactly what students must know and be able to do by the time they reach 8^{th} grade. The 8^{th} grade teacher may begin to understand what students in 5^{th} grade were taught and what resources and teaching methods were used. Vertically-aligned curriculum understanding can improve the science learning outcomes for students in all grades.

The project intends to change the manner in which teachers approach science subjects, bringing 21^{st} century learning strategies into the classroom. Activities have been designed to increase student science knowledge by ensuring that participating teachers acquire deep science content knowledge as demonstrated through the development of sound inquiry-based lessons. Teachers learn how to develop and implement problem-based activities that engage their students so that they better understand the science content. These lessons require students to use analytical and investigation skills to demonstrate their understanding of key concepts.

The project's objectives are aligned to the following MMSP program goals: (1) develop and implement an effective and sustained course of study for multi-district in-service teachers of science, technology/engineering and mathematics (STEM) by integrating the courses of study into the UMASS Boston COSMIC center that includes faculty from the colleges of science and

math and the college of education; (2) increase the number of science teachers in the collaborating schools who are licensed in the subject area(s) and grade level(s) they teach; (3) increase the number of STEM teachers in the collaborating schools who participate in high quality professional development and advance their content knowledge; and (4) develop and implement a systemic approach to STEM education by integrating professional development with district and school improvement initiatives.

Key Evaluation Questions

The formative evaluation questions focus on the nature, quality and outputs of the project.

1) What is the nature and quality of the key components of the TRITEC intervention?
2) Each year, does the project meet its goals in terms of the number of participating teachers and the number of courses taken?

The summative evaluation questions (3 and 4) that will be addressed over the course of the evaluation are:

3) Do teachers who participate over multiple years demonstrate greater benefits in terms of pedagogy and content knowledge than teachers who participate in a single year?
4) What is the impact of the project? What are the most important components of the intervention that leaders and participants believe led to desired outcomes? What is the impact of the project on participating teachers? Specifically, how did the project change participant teachers' science content knowledge and pedagogical approaches? What is the impact of the project on students of participating teachers?

The project Leadership Team articulated project benchmarks or criteria against which progress was assessed and informed each evaluation question. Draft benchmarks were presented in the proposal and were refined by the Leadership Team during the first two years of the project. The refined benchmarks are presented in the chart below.

Chart 1. Collaborating to Create a Science Learning Community
Evaluation Questions and Associated Benchmarks

Evaluation Question	Benchmark
What is the nature and quality of supports offered by partner districts?	• At least 2 meetings will occur each year with participation across all partners • At least 70% of teachers will report that the courses are high quality as measured by post-course surveys • At least 70% of teachers will report increases in confidence attributed to the courses
What percentage of teachers who enrolled in the courses completed each course?	• At least 75% of teachers registered in courses will complete all course requirements
What percentage of teachers significantly increased their content knowledge in science?	• At least 70% of teachers will significantly increase content knowledge
What percentage of teachers reported improvements in students' science content knowledge?	• At least 70% of teachers who complete courses will report improvements in their students' science content knowledge

Evaluation Question	Benchmark
What is the impact of the project on participating teachers?	• Teachers completing course will report impact on content knowledge and inquiry-based teaching practices
What is the impact of the project on students of participating teachers?	• Annually a sample of students of participating teachers completing project courses will demonstrate significant content gains when compared with non-participating teachers' students.

III. Recruitment

Planning meetings identified a variety of areas of science content needs based on changing district curricula, MCAS performance analysis and existing teacher skills and experience. Teachers were surveyed to determine preferred content and format for delivery of the courses. District administrators and curriculum leadership discussed and identified the specific science professional needs of their teachers to ensure that the course offerings met the needs identified by both the teachers and their administrators. All of this information was incorporated into the project design.

For the partnering school districts and schools, all teachers who teach science grades 5-9 (including special education and ELL) were recruited. Targeted recruitment included: (1) ensuring that teacher applications were widely circulated, since all grant work occurs during the summer or on an afterschool basis, with participating teachers each receiving three graduate credits per course (all teachers were also eligible to receive a stipend for completing the 32 hours of supplemental activities); (2) holding district informational sessions conducted by the Teacher Learning Center Directors and curriculum directors, highlighting the integration of content and state learning standards embedded within teacher-created project lessons; (3) working with central administration and targeted school principals to offer incentives for teacher project participation to include, but not limited to, extensive in-service credits, and the application of graduate credits earned towards other graduate programs in which teachers are enrolled, and/or for district salary increases; and (4) working with school principals to uncover teacher incentives for project participation that may have been pertinent to a particular school only (i.e. some schools are looking towards creating upper elementary math/science specialist positions).

Once teachers were recruited according to the plans outlined above, those teachers worked closely with each district's science curriculum director to ensure that lesson development addressed stated MCAS and other school benchmark science deficiencies.

Recruitment was a topic discussed in the project's 2012 Advisory Board/Leadership Team meetings. During the 2011/2012 academic year, many districts throughout Massachusetts received Race to the Top funds that offered teachers professional development opportunities to learn specific content and engage in new teaching practices. Many of the target teachers for the science courses had multiple days of new professional development required by their districts. Due to these unanticipated recruitment difficulties, the project worked collaboratively with the Boston Science Partnership initiative to recruit participants for the Biology course offered during the summer of 2012. The Earth Science course had 23 teacher participants (goal 25). A total of 87% of these teachers were from high-need schools/districts. The Biology course had 18 teacher participants (goal 25), and 11 of the 18 teachers were from *Collaborating to Create a Science Learning Community* project partnership districts/schools. A total of 66.7% were from high-need schools/districts. Across both courses offered, 78% of participating teachers were from high-

need schools/districts. A total of 78% of the teachers participating in the Earth Science course were from the partnering districts and a total of 44% of teachers participating in the Biology course were from the partnering districts. A total of 65% of teachers participating in the Earth Science course were highly qualified to teach Earth Science and a total of 61% of teachers participating in the Biology course were highly qualified to teach Biology. One teacher participating in the Earth Science course and one teacher participating in the Biology course indicated that they were pursuing a degree in science.

In Year 1 of the project, recruitment targets were met for the Biology course but not for the Physics course. The Physics course had 18 teacher participants (goal 25), 17 of the 18 were from *Collaborating to Create a Science Learning Community* project partnership districts/schools. A total of 89% of these teachers were from high-need schools/districts. The Biology course had 25 teacher participants (goal 25), and 11 of the 25 teachers were from *Collaborating to Create a Science Learning Community* project partnership districts/schools. Sixty-seven percent of these teachers were from high-need schools/districts.

IV. Formative Evaluation

A. Purpose. The purpose of the formative evaluation was to provide project leaders with regular findings regarding the degree to which the project was meeting desired targets so that mid-course corrections could be made.

B. Methods. TRITEC hired an external evaluation team from EAS, Inc.

1. *Participants* in the evaluation are listed in the table below.

2. *Design*. The evaluation team employed a mixed-methods participatory evaluation design to obtain, analyze and report formative evaluation data. The evaluation team obtained data about the nature and quality of project activities to guide decision-making for future activities.

3. *Instruments/Protocols.* The external evaluation team developed surveys, observation protocols, and semi-structured interview protocols to collect formative evaluation data. The instruments and protocols are described in the table below. The evaluators developed: a) semi-structured interview protocols to collect data from participating teachers; b) observational protocols; c) Pre and Post Professional Development Surveys designed using items from established validated surveys including the International Society for Technology in Education (ISTE) National Technology Education Standards (NETS) items and questions used by other Mathematics and Science Partnership projects. These surveys were designed to capture baseline attitudes, knowledge and practices related to the University of Massachusetts Boston (UMB) science courses (focused on content and pedagogical approaches) and related to the follow up workshops (focused on teaching science using Web 2.0); and d) document review protocols. In addition, the evaluation team used the Reformed Teaching Observation Protocol (RTOP) to collect observational data. The Reformed Teaching Observation Protocol (RTOP) was created by the Evaluation Facilitation Group (EFG) of the Arizona Collaborative for Excellence in the Preparation of Teachers (ACEPT). It is an observational instrument designed to measure "reformed" teaching. This tool, developed with support from the National Science Foundation is designed to capture key elements of reformed teaching as articulated in the National Research Council 1996 report on science teaching and learning. Specifically, it captures the degree to which a teacher supports

inquiries while interacting with students, orchestrates discourse among students about scientific ideas, challenges students to accept and share responsibility for their own learning, recognizes and responds to student diversity and encourages all students to participate fully in science learning, and encourages and models the skills of scientific inquiry as well as curiosity and openness to new ideas.

4. *Data Collection Procedures.* The evaluation team is comprised of researchers with doctoral level training in the collection, analysis and reporting of valid and reliable evaluation data. All data was collected employing procedures that ensure reliability. To collect data related to the quality of partner supports, the evaluation team participated in project activities and events and collected data using observation and interview protocols. These data were collected using a running record and were subsequently coded. To obtain data about the participants' perceptions of the quality of supports and to learn about reported changes in attitudes and teaching practices, surveys were administered using SurveyMonkey prior to the first day of class and after participants completed 7 of the 8 workshops. A comparison group of teachers from the partnering school districts was recruited to complete the survey. The comparison group consisted of teachers who the curriculum directors had targeted for participation in the course but who were not participating. The evaluation team used protocols to clean and code secondary data that were included in the evaluation report and internal reliability checks were conducted. Finally, document review protocols were used to analyze existing data.

Chart 2. Formative Data Collection Activities

Data collection instrument/ Procedure	Description	Year 2 Participants (Number)	Year 1 Participants (Number)
Observations, informal interviews, and semi-structured interviews	Project Team meetings (in person participation)	12	12
	Informal conversations with Leadership Team members	Various	Various
	Semi-structured interviews with teachers	8	6
	Observations of participating teachers' classrooms using the Reformed Teaching Observation Protocol	8	4
	Observation of call back	2 events	2 events
Surveys	Pre and Post Professional Development Surveys:		
	Matched pre-post*	41	32
	Comparison group	17	0
Document Review	Project communications	Various	Various
	Course materials +		
	Course attendance and completion data+		
	Artifacts from courses and from teachers including postings to the Wiki; final lessons		
	TRITEC documentation		

* A total of 41 post surveys were completed in year 2 but 1 teacher participant began the course late and did not complete a pre-survey. A total of 32 matched pre-post surveys were completed in year 1.
+ Data collected by TRITEC/collaborating districts, UMB faculty, and/or entered/reported by UMass Donahue Institute.

5. *Analysis*. Evaluators used qualitative and quantitative methods to examine and describe project activities and associated impacts on teachers and their students. The quantitative data analysis included simple descriptive statistical analyses of quantitative data. The evaluators performed inferential statistical analyses including dependent samples t-tests to assess changes in teacher and student content knowledge and independent samples t-test analyses to examine differences between groups. The qualitative methods were guided by Miles & Huberman's framework of creating an initial coding schema, refining the codes after preliminary analysis, and exploring emerging themes and trends (Miles, M. & Huberman, A., 1994). Qualitative data were coded based on a schema that examined the relationship between actors (such as Leadership Team members and teachers), activities (such as the regular project meetings and the science courses), outputs (such as teacher attendance rates and their final course products), and outcomes (changes in participating teachers perceptions of their knowledge of science content and their ability to teach science).

C. Formative Findings

1. *Response rates.* A total of 40 teachers completed the matched Pre and Post Professional Development surveys in Year 2. This represents 97.5% of all participants who completed the courses. All 41 teachers (100%) completed anonymous Post-Professional Development surveys. A total of eight teachers volunteered for observations and for participation in semi-structured interviews.

2. *Findings.* In Year 2, with support from the Leadership Team, all planned activities were successfully completed. (This was similar to the findings in year 1.) These activities were:

- Implemented the planned professional development (the University of Massachusetts contextualized curriculum courses and the supplemental opportunities which consisted of a series of 8 workshops on inquiry-based learning and Web 2.0 skills in the science classroom); the development and implementation of these activities leveraged lessons learned from previous MSP projects
- Recruited a total of 39 unique individual teachers (with 2 teachers taking both courses) who completed graduate-level science courses
- Ensured teachers represented a broad range of grades and taught in classrooms in which children reflected a broad range of socioeconomic backgrounds by targeting teachers from the collaborating school districts (78% of participants were from high-needs districts)
- Refined the curriculum as well as the format of the courses to reflect the unique needs and background characteristics of participating teachers
- Successfully met the benchmark of ensuring that at least 75% of recruited teachers completed the graduate coursework
- Provided teachers with an opportunity to share perspectives regarding the development of lessons and learn from teachers who had implemented the lessons about their experiences
- Used formative data to revise activities with the aim of meeting the needs of participants, and their schools

In addition, the project met nearly all planned benchmarks related to project activities. Year 2 participants taught a total of 317 mathematics students and 3,467 science students. The sole exception to meeting project benchmarks in Year 2 was that the enrollment in the professional development was lower than anticipated—with enrollment of 41 instead of the target of 50. The Leadership Team met to discuss ways to ensure future year's enrollment and developed strategies to engage curriculum directors and teachers earlier in the recruitment process to reach enrollment targets in future years.

Per the original design, a total of 2 University of Massachusetts, Boston graduate courses were offered annually to teachers in the collaborating districts:

1) Earth Science: Weather and Water (Year 2)
2) Biology: Ecology, Evolution, and Diversity of Life (Year 2)
3) Physics: Electricity and Magnetism (Year 1)
4) Biology: Cell Biology and Genetics (Year 1)

The project successfully met the Year 2 benchmark of ensuring that at least 75% of the recruited teachers completed the courses. (This finding was similar in Year 1). In fact, 41 of the 42 Year 2 teachers who began the courses in earnest completed the courses.[2] Moreover, 40 of the 42 individuals completed all aspects of the professional development—a completion rate of over 95%.

Similar to reports in Year 1, in Year 2 the Leadership Team and instructors reported that the faculty teaching these courses used lessons learned from the Boston Science Partnership and from previous MSP courses to inform pedagogical approaches, content and format of the courses. Project leaders collaborated with other MSP projects to inform recruitment strategies. Each course used pre-test and regular assessment data to offer differentiated instruction targeted to the baseline content knowledge and abilities of the participating teachers. In addition, each course was designed to address the Massachusetts curriculum frameworks. Per the original design, the courses were co-taught by university faculty and K-12 classroom teachers.

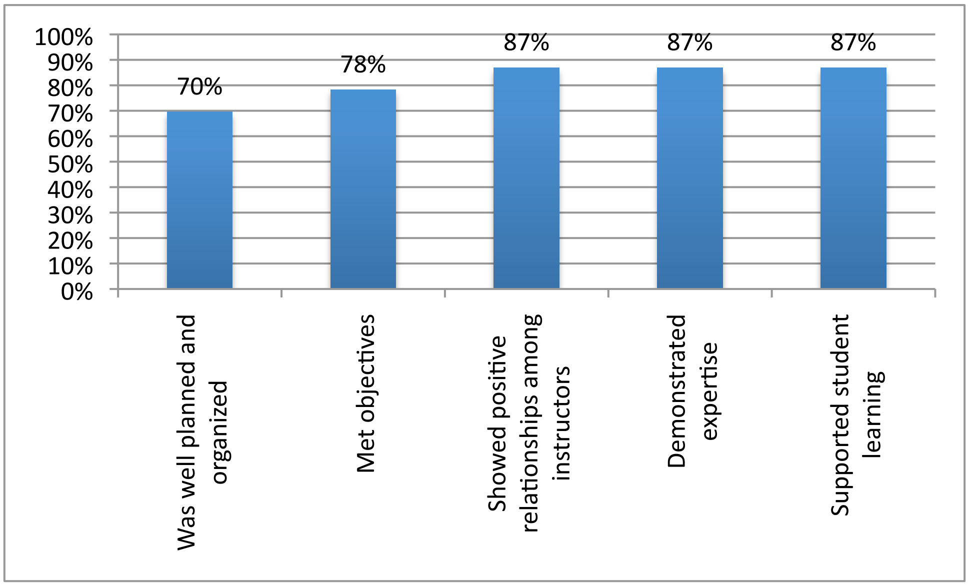
Participants Provided Positive Reports about the Professional Development

The project successfully met the benchmark that at least 70% of completers would provide favorable reports about the professional development activities. This finding was similar to the Year 1 finding. Participating teachers completed Post Surveys that included questions about the quality of the professional development.

The graphic 1 below illustrates participants' perspectives of the professional development courses and follow-up supplemental activities. The participants provided favorable ratings regarding the instructors, the structure, and the way in which the experience contributed to their development of a learning community. As illustrated in graphic 1 below, 87% of the year 2 teacher participants reported that the course instructors demonstrated a positive working relationship, demonstrated expertise, and supported student learning, and over 70% reported that the course was well planned and organized and met the stated objectives.

[2] Three additional teachers expressed initial interest in the courses decided not to enroll after obtaining information about the course requirements.

Graphic 1. Percent of Year 2 Participants Who Agree with Statements Regarding Instructors and Courses



% agree, scale 0%-100%

Trends were similar across all of the courses that were offered in both years of the project. For example, in Year 1, about 90% of participants reported that the instructors demonstrated a positive relationship and expertise, compared with 87% of Year 2 participants.

Year 2 participants were also asked for suggestions to inform the refinement of future professional development activities. Teachers who participated in both the Earth Science and Biology courses and the supplementary activities liked the formats, even though the Earth Science course was offered during the school year, and the Biology course was offered during two weeks in the summer. Some of the elementary school teachers reported that they "struggled" with the science content but felt they learned important principles and concepts while other elementary school teachers reported that the courses were well suited to their background knowledge.

Illustrative comments about the Year 2 Biology course from teachers include:

> This is a great class. Thank you for letting me participate. [Middle school from suburban district]
>
> The conceptual approach broadened my understanding of evolution and ecology. The instructors were knowledgeable and enjoyed sharing their knowledge as well as facilitating discussions and answering questions. Other students offered useful teaching ideas. [Elementary school teacher from high-needs district]

Comments about the Year 2 Earth Science course are as follows:

> It was a great and challenging experience. So much learned and so much more to go. [Elementary school teacher from high needs district]
>
> I found this class to be very helpful in expanding my content knowledge, improving my pedagogy and stimulating me to think of new ways to understand what is happening at the molecular level. [Middle school teacher from high-needs district]

D. Usage

During Year 2, the project successfully completed all planned activities and met all benchmarks except the recruitment target. The Leadership Team used formative data to refine activities. The evaluator participated in regular meetings with key leaders to share lessons learned and early insights. Leadership Team members reflected on the professional development structure and location, and plan to use the data collected to inform future activities. The evaluation team also gathered formative data related to the supplementary activities and this information and the usage are presented in section VIII.

V. Impact of Activities on Teacher Content Knowledge

A. Methods

1. *Participants.* All 41 teachers who participated in Year 2 project activities completed Post Teacher Content Knowledge Assessments. All (100%) of the Year 2 teachers completed Post Professional Development Surveys and all but one teacher completed both the Pre and Post Professional Development Survey. In addition, observation data were collected from 8 teachers who had completed courses and 8 teachers were interviewed. The observations were from 4 teachers who had completed the Earth Science course and 4 teachers who had completed the Biology course. Three participants who were observed had taken the Physics course that was offered during year 1. The evaluators also reviewed lessons developed by 30 teachers in Year 2. All 43 Year 1 teachers completed Pre and Post Teacher Content Knowledge Assessments. From Year 1 teachers participating in the project, a total of 32 matched surveys were collected and analyzed (13 from Physics and 19 from Biology participants).

2. *Design*. The external evaluation team used a single group within subjects design that was based on a criteria-based evaluation approach (Wilson & Onwuegbuzie, 1999). The evaluators analyzed the data against the desired benchmarks established by the Leadership Team to determine if the desired targets were met. For the summative evaluation component, the external evaluation team used a criteria-based evaluation approach (Wilson & Onwuegbuzie, 1999) in which performance was measured against desired benchmarks established by the Leadership Team.

3. *Instruments/Protocols*. The external evaluation team developed instruments and protocols, which are presented in the table below. The evaluators used the following instruments/protocols to collect data:

   a) A semi-structured interview protocol was used to capture attitudes, knowledge and practices of participating teachers related to science teaching and student learning.

   b) Three different types of observational protocols were used. First, the evaluators used a running record of classroom teachers facilitating lessons developed through the courses

they had taken. Secondly, the evaluators collected data in these classrooms using the Reformed Teaching Observation Protocol (RTOP). The Reformed Teaching Observation Protocol (RTOP) was created by the Evaluation Facilitation Group (EFG) of the Arizona Collaborative for Excellence in the Preparation of Teachers (ACEPT). It is an observational instrument designed to measure "reformed" teaching. This tool, developed with support from the National Science Foundation is designed to capture key elements of reformed teaching as articulated in the National Research Council, 1996 report on science teaching and learning. Specifically, it captures the degree to which a teacher supports inquiries while interacting with students, orchestrates discourse among students about scientific ideas, challenges students to accept and share responsibility for their own learning, recognizes and responds to student diversity and encourages all students to participate fully in science learning, and encourages and models the skills of scientific inquiry as well as curiosity and openness to new ideas. Thirdly, the evaluators collected data using a running record to capture qualitative data from teachers presenting their perspectives on their lessons during a call-back meeting that was held after participants had completed the course and the supplemental activities.

c) Pre and Post Professional Development Surveys—designed to capture baseline attitudes, knowledge and practices related to the University of Massachusetts Boston science content courses (focused on content and pedagogical approaches) and related to the supplemental activities (focused on teaching science using Web 2.0 technologies). The Pre Professional Development Survey included a set of questions about technology confidence and use, a set of questions about current pedagogical practices, and a set of questions about confidence employing a range of pedagogical practices specific to science teaching. The Post Professional Development Survey included the same set of questions on the Pre Survey but also asked participants about perceived impact of the professional development.

d) Document review protocols were employed to assess the quality of lessons developed by participants.

e) Teacher content gains were assessed through secondary analysis of Biology Teacher Content Knowledge Assessment data as well as Earth Science Teacher Content Knowledge Assessment data that were collected by University of Massachusetts Boston (UMB) faculty prior to and after completion of each science content course. The UMB faculty developed these instruments. Each assessment was administered to participants prior to taking each course and during the last day of the course. No analyses were performed to assess the validity or reliability of the university faculty-created assessment instruments. (See Appendix for sample content assessment.)

4. *Data Collection Procedures.*

a) The semi-structured interview protocol was administered to teachers who volunteered for interviews. The questions were asked after the classroom observations were conducted.

b) Evaluators observed classrooms and collected data using the running record and RTOP from classroom teachers as they facilitated lessons developed through the courses they had taken. Each observation was for one course period; course periods ranged from 45 minutes to 90 minutes. The evaluators used a running record to capture qualitative data from teachers presenting their perspectives on their lessons during a call-back meetings.

The call-back meetings averaged 2.5 hours in length.

c) The evaluation team collected Pre and Post Professional Development Survey data using SurveyMonkey—an online web-based survey. Participants were given information about the Pre Professional Development Survey at the orientation and were required to complete the Post Professional Development Survey as part of the last online workshop.

d) Document review protocols were employed to assess the quality of lessons developed by participants. The team used document review protocols to review teacher lessons posted to the project's Wiki spaces pages. The protocol used with a dichotomous rating giving a 1 for the existence of the following in each lesson: 1) introduction which clearly describes the essential question the lesson is addressing; 2) description of the task or activity each student will be asked to engage in and clearly describes the tools and resources needed to complete the task; 3) a detailed description of the process that includes a listing of the steps required for learners to complete the task successfully; 4) instructions to the students that are clear and incorporate inquiry-based pedagogical strategies; 5) existence of clear standards based learning outcomes that are expected from students. [The external evaluator did not include a criteria regarding the content of the lesson since the content was based on that covered in the graduate courses.]

e) The Teacher Content Knowledge Assessments were administered to teachers participating in the courses the first morning of class and the last day of class.

B. Results

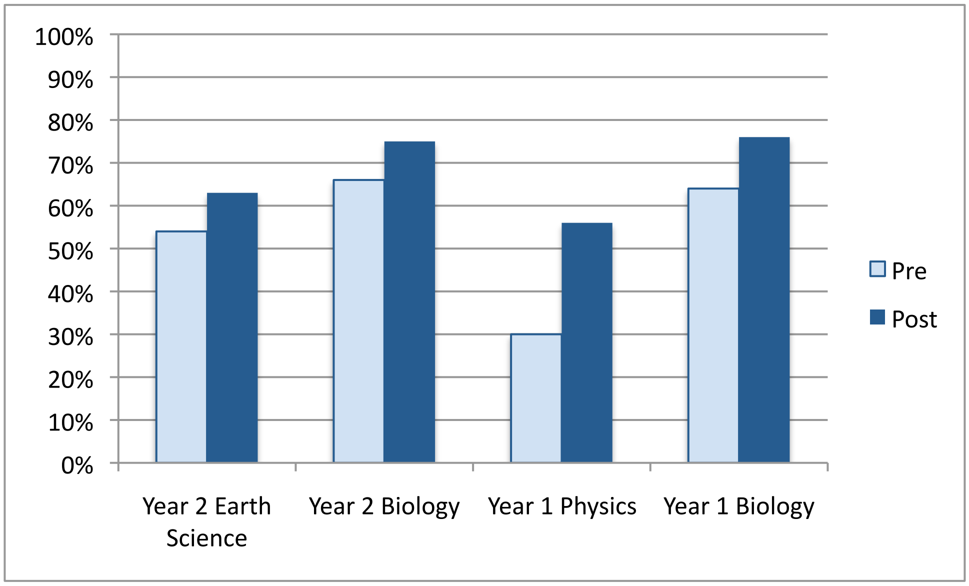
Response rates. All 41 Year 2 participating teachers completed Pre and Post Content Knowledge Assessments yielding a response rate of 100%. A total of 40 teachers completed the matched Pre-and Post- Professional Development surveys resulting in a response rate of 97.5%. All 43 Year 1 teachers completed Pre and Post Content Knowledge Assessments yielding a response rate of 100%. All (100%) of the Year 2 teachers completed Post Professional Development Surveys and all but one teacher completed both the Pre and Post Professional Development Survey. Seventy-three percent of Year 1 teachers completed Pre and Post Professional Develoment surveys.

In addition, 8 teachers who had completed courses were observed and interviewed. The observations were from 4 teachers who had completed the Earth Science course and 4 teachers who had completed the Biology course. Three participants who were observed had taken the Physics course that was offered during year 1. The evaluators also reviewed lessons developed by 30 teachers in year 2.

1. *Findings.* Dependent samples t-test analysis revealed that both groups of teachers participating in Year 2 courses demonstrated strong and statistically significant gains in content knowledge after taking the course. Teachers taking the Earth Science course demonstrated a large and significant increase between pre-test scores *M.56, SD=.14*, and post-test scores *M=.64, SD=.15*, df(23), (*t=5.22, p=.000)*. Teachers taking the Biology course demonstrated a large and significant increase between pre-test scores *M=.63, SD=.11*, and post-test scores *M=.75, SD=.09*, df(17), (*t=4.99, p=.000)*. The findings

from Year 2 were consistent with those demonstrated from teachers who participated in the courses in Year 1. See Graphic 2 below.

Graphic 2. Teacher Participants' Pre and Post Content Knowledge Assessments (Percent Correct, Range 0-100)



Mean % correct, scale 0%-100%

Teachers participating in Year 2 activities reported in their own words that the professional development led to increases in content knowledge. Teachers in the Earth Science class reported they learned about global warming, and erosion, and participants in the Biology course reported learning about evolution and natural selection. Examples of teacher reports of content learning are presented below:

> I am able to explain classification better and have acquired resources that will make my teaching better on this topic. [Middle school teacher from Biology course, high-needs district]

> I learned a lot about how a species works to promote reproduction. I have a better understanding of how invasive species alter the environment. [Elementary school teacher from Biology course, high-needs district]

> I got to understand better the greenhouse gases and global warming as well how the weather is affected by them. [Elementary school teacher from Earth Science, high-needs district]

> The single most important concept that I learned was how to think about what is happening at the molecular level when we observe macroscopic phenomena. [Middle school teacher from Earth Science, high-needs district]

> I better understand heat transfer and how it can be found in nature.[Middle school teacher from Earth Science, suburban district]

C. Discussion

A primary aim of the project has been to provide professional development to teachers to increase their science content knowledge. To achieve significant gains in content knowledge, the research literature suggests that professional development must be of sufficient quality, depth, and duration. Reviews of research on professional development reveal that many early professional development innovations show mixed or limited outcomes regarding gains in teacher content knowledge (Fishman, Marx, Best, & Tak, 2003). It is therefore notable that the project achieved the goal of increasing participating teachers' content knowledge. For teachers participating in the courses across both years, the content gains were statistically significant *($p<.05$).*

VI. Impact on Teacher Classroom Practice

A. Methods

The methods to assess impact on classroom teaching practice are described in Section V above.

B. Results

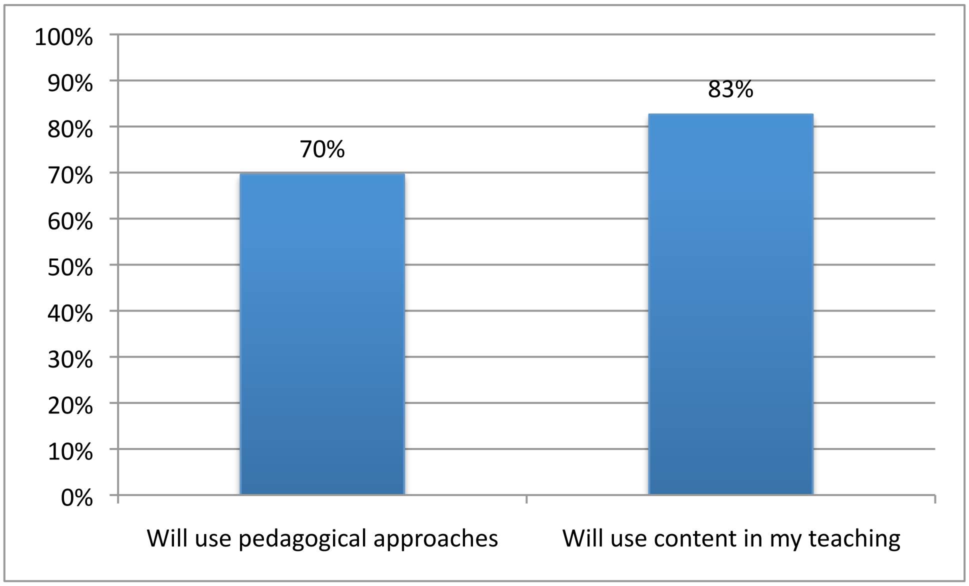
1. *Response Rate.* All 41 Year 2 participating teachers completed Pre and Post Content Knowledge Assessments yielding a response rate of 100%. A total of 40 teachers completed the matched Pre-and Post- Professional Development surveys resulting in a response rate of 97.5%. All 43 Year 1 teachers completed Pre and Post Content Knowledge Assessments yielding a response rate of 100%. All (100%) of the Year 2 teachers completed Post Professional Development Surveys and all but one teacher completed both the Pre and Post Professional Development Survey. Seventy-three percent of Year 1 teachers completed Pre and Post Professional Develoment surveys.

   In addition, observation data were collected from 8 teachers who had completed courses and 8 teachers were interviewed. The observations were from 4 teachers who had completed the Earth Science course and 4 teachers who had completed the Biology course. Three participants who were observed had taken the Physics course that was offered during year 1. The evaluators also reviewed lessons developed 30 teachers in Year 2.

   Findings. Across both years of the project participants were asked questions about whether the course has had an impact to date and whether they believed it would have an impact in the future. Both Year 1 and Year 2 participants reported that the professional development has had an impact on their teaching and reported that they believe it will continue into the future. A total of 74% of the Year 2 teachers reported on the Post Survey that the courses had already had an impact on them as teachers. Teachers who completed Post Professional Development Surveys reported that they planned to use the pedagogical approaches and content in their teaching. (See graphic 3 below.) A somewhat lower percentage of Year 2 participating teachers reported that they planned to use the content in their teaching when compared with the Year 1 results. Analysis of qualitative data suggests two possible reasons. First, a number of teachers reported that they were not teaching the specific content that they had been taught. Secondly, some

teachers who had taken multiple courses funded through the Mathematics and Science Partnership project reported that they had already incorporated pedagogical changes and did not plan to implement additional pedagogical changes in the upcoming academic year.

Graphic 3. Year 2 Post Professional Development Survey Results

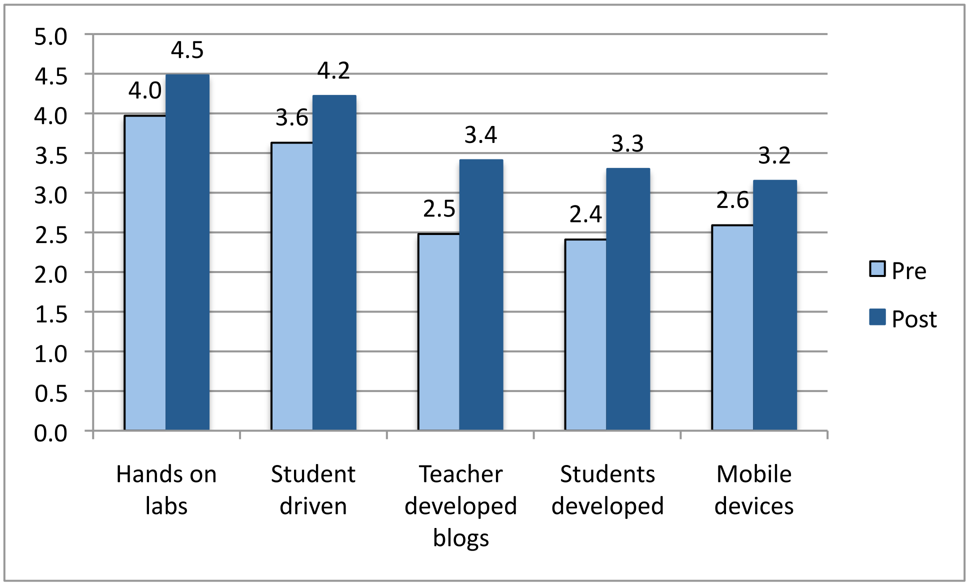


% agree, scale 0%-100%

Analysis of matched pre and post survey data and analysis of teacher interview data from Year 2 teachers reveals significant changes in self-reported classroom teaching practice by teachers who had taken the Earth Science and Biology courses.

Teachers reported feeling more confident teaching science using a range of pedagogical strategies and approaches. Teachers reported increases in confidence teaching hands-on labs, employing student-driven approaches, and using Blogs and online social networks to teach science. Teachers also reported feeling more confident developing Blogs or online lessons, encouraging their students to develop Blogs and using mobile devices to teach science content. (See graphic 4.)

Graphic 4. Year 2 Participants' Pre and Post Professional Development Survey Results: Changes in Confidence Employing Different Pedagogical Techniques (Scale 1-5 with 1=Low and 5=High)



Average confidence, scale 1=low, 5=high

Teachers reported a deeper understanding of pedagogical approaches that engage students. Teachers from the Earth Science course reported that the faculty modeled specific pedagogical techniques and teachers from the Biology course reported that the instructors provided information on innovative pedagogical techniques. Quotes from a range of different teachers, which illustrate the range of pedagogical approaches participants learned and the approaches teachers are applying are presented below.

> I found the 7 E approach is very useful. In addition the hands on activities were excellent [and I am now using these in my course]. [Middle school teacher from Biology course, high-needs district]
>
> Use of elicit activities and probes [has been informative.] I also developed an activity to extend and expand lessons.
>
> I modified my lessons using the 7E model during this summer. I am also implementing technology in a more flexible way during my lessons after this course. [Middle school teacher from Biology course, suburban school]

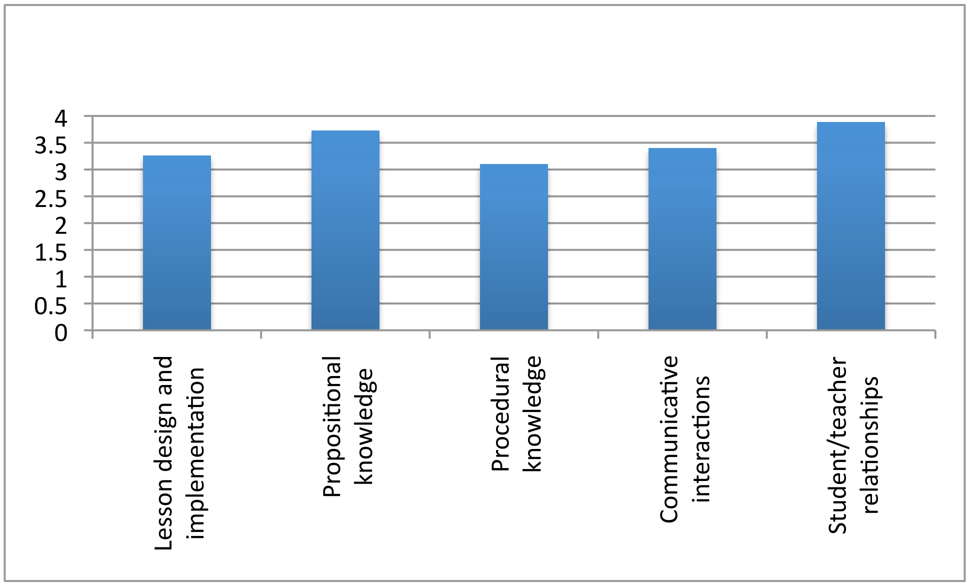
Observational evidence revealed that teachers were employing pedagogical approaches that were demonstrated. In one elementary school classroom, the teacher began a new unit by asking students to present their prior knowledge on the topic. Each student wrote on a piece of paper and then the teacher presented a brief video. After viewing the video, students engaged in a hands-on activity in small groups. The students encouraged one another to participate and offered suggestions to one another. The teacher then re-convened the large group and asked students again to answer the questions she posed at the beginning of the class, noting misconceptions that students had presented at the beginning of class and commenting on the students' growth in understanding after viewing the video and engaging in the activity.

At another observation of a middle school class, the teacher asked students to work in small groups at the computer to answer a series of questions about global warming. Students were

encouraged to think about the benefits and problems associated with global warming. One small group included two students with special needs. Student groups, including the group with the two special needs students, then presented to the large class. Each group listed challenges and benefits of global warming and engaged in debate.

To learn about the relative strengths of the project and opportunities for the project to improve supports in the future, the evaluation team observed a sample of eight teachers. These teachers volunteered to allow the evaluation team to observe the implementation of a lesson they had developed for the project at a pre-arranged time. The evaluators used the Reformed Teaching Observation Protocol (RTOP). Analysis of observational data revealed that the teachers who volunteered to participate in observations demonstrated very high scores overall on the RTOP. Since teachers volunteered to participate, implemented lessons that were reviewed by Teacher Learning Center Directors, and engaged instructional supports prior to lesson implementation, the overall high scores were not surprising. (See Graphic 5 below.)

Graphic 5. Mean RTOP Scores by Sub-scales



Scale 0=never occurred, 4=very descriptive

The graph above illustrates variation across the 5 RTOP sub-scales: lesson design and implementation; propositional knowledge;[3] procedural knowledge, communicative interactions, and student/teacher relationships. (These scales and each item in the RTOP is presented in the appendix.) The graph illustrates that the evaluators observed classrooms with evidence of strong student/teacher relationships and communicative interactions. At the same time, procedural knowledge scores (which focuses on the kinds of processes that students are asked to use to manipulate information, arrive at conclusions, and evaluate knowledge claims) were lower. Moreover, lesson design and implementation were lower. The lower scores on these scales reveal opportunities for the project to support lesson implementation and to help teachers support students' engage in procedures that support scientific inquiry.

[3] Propositional knowledge focuses on the level of significance and abstraction of the content, the teacher's understanding of it, and the connections made with other disciplines and with real life.

A. Discussion

Teachers who participated in the project reported changes in classroom practice and observational evidence revealed inquiry-based practices and hands on labs. While teachers demonstrated evidence of inquiry-based teaching, some elementary and middle school teachers were challenged in encouraging divergent perspectives and encouraging students to rule out alternative hypotheses. The evaluation team will continue to collect data from teachers who are implementing lessons in the upcoming months and will report this data in next year's report.

VII. Impact on Student Achievement

A. Methods. TRITEC hired an external evaluation team from EAS, Inc.

1. *Participants*. Student data are reported from Year 2 only as limited data were collected in Year 1. This year's report includes data from all of the 41 teachers who completed the Post Professional Development Surveys who provided reflections on their perceptions of the impact of the professional development on their students and from a review of data from a sample of students. Data from students was from two teachers who volunteered to share pre and post data with the evaluation team and from one teacher who provided a small sample of comparison student data.

2. *Design*. The design is a single subject pre and post design with triangulated data from teacher reports.

3. *Instruments/Protocols.* Teachers developed the student assessments based on previously published Massachusetts Comprehensive Achievement System (MCAS) assessments. No psychometric analysis has been performed on the teacher-developed assessments but the original MCAS items have been validated. The external evaluation team developed Pre and Post Professional Development Surveys, observations of students using a running record, and semi-structured interview protocols with questions about the impact of the project on content knowledge, teaching practice and students' outcomes to collect evaluation data. The Pre and Post Professional Development Surveys asked participants questions about the impact of the course on their students. To enhance reliability of the Survey the instrument used Likert Scale items. To enhance validity, the Survey used items from national surveys and from surveys used by other MSP projects.

Data Collection Procedures. The teacher who provided pre and post student assessment data administered the assessment prior to introducing the lessons and after the lesson was complete. The teacher who provided data from her students and from comparison students administered the same assessment to one group of students who had participated in the lesson she developed from the course and to a comparison group of students she taught. Survey data were collected using SurveyMonkey and observation data were collected using a running record.

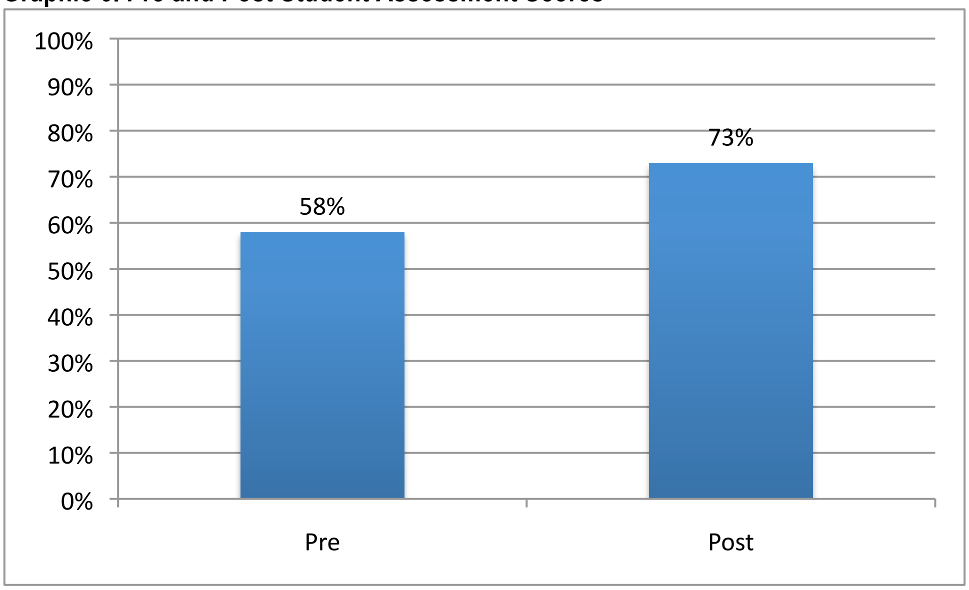
B. **Results**

1. *Response Rate.* For the Year 2 report, teachers were asked to share pre and post assessment data with the evaluation team. The evaluation team had originally planned to collect data from a

small sample of students. Two teachers volunteered to share student assessment data with the evaluation team. One teacher who had taken the Biology course provided a total of 42 matched student pre and post assessments. These represent 91% of students who were taught by the teacher. A second teacher who taught English Language Learners provided pre and post scores from 6 students who participated in a lesson she developed for the Biology course and 6 comparison students.

2. *Findings.*
Analysis of pre and post assessment data from the sample of 42 matched assessments reveals that these students demonstrated statistically significant knowledge gains after participating in a science lesson taught by a participating teacher. The mean score prior to participating in the lesson *was 58% correct, (SD= 27%)* and after participating in the Biology lesson the mean was 74% correct *(SD=22%).* Dependent samples t-test analysis revealed statistically significant gains *(df=19, t=2.5, p<.05).* Graphic 6 below illustrates the gains from the group of students participating in the Biology lesson.

Graphic 6. Pre and Post Student Assessment Scores



Average correct score, scale 0%-100%

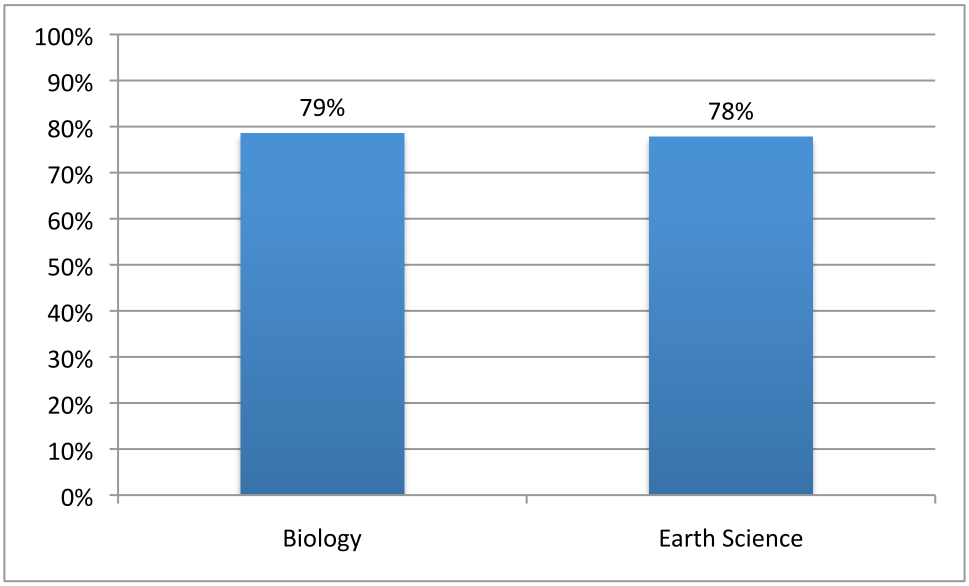
Analysis of data from the 6 students who participated in the Biology lesson and the 6 comparison students revealed that the students participating in the lesson scored an average of 95% correct on the post test whereas the comparison students scored an average of 50% correct.

Observation data reveal students' engaged in inquiry-based lessons demonstrated both enthusiasm and surprise that the teacher is not simply giving them answers. During observations of two classes comprised of mostly English Language Learners, non-English speaking students engaged in the hands-on activities, demonstrated processes to one another, and – as the teachers translated the assignment, successfully completed the assignments. During follow up interviews with teachers, both reported that they were surprised by their students' level of engagement, interest in learning, and ability to grasp complex concepts through hands-on lessons.

In Year 2, teachers reported that they believed their participation in the professional development would have an impact in the coming year. Graphic 7 below illustrates that nearly 80% of

participants in each course reported that they believed the professional development would have a positive impact on their students.

Graphic 7. Percent of Participating Teachers who Believe Course Will Have Direct Positive Impact on Their Students



Average correct score, scale 0%-100%

A number of teachers reported to the evaluators that they believed the professional development already had a positive impact on their students. One teacher reported:

> I recently tried the inquiry-based activity in my bio class on a bio topic and found that it worked extremely well. Giving them [my students] many materials to work with and having them design something on their own with no instruction from me was very interesting. I thought they might be stuck at first for many want to just follow directions or steps given to them but that was in fact not the case. Many really thought out of the box and showed that they truly understood the concepts. [Middle school teacher from Biology course, high-needs district]
>
> I asked my students why there are seasons. We are dealing with misconceptions students have beginning with heat. They find it helpful to break things down by looking beyond earth and space. They have reflected in the water cycle and have a chance to think about their own experiences. [Middle school teacher from Earth Science course, high-needs district]

Teachers who reported that the course would not have a positive impact on their students provided reasons for their answers. Some indicated that they did not teach the specific content, one reported that she found the content to be interesting but did not know how to incorporate it into her lessons because it did not align completely with her curriculum frameworks, and one reported that she was an administrator and would not be teaching students directly.

B. Discussion

Preliminary data reveal that teachers believe the professional development will have or has already had an impact on their students. Teachers who completed the project have developed

lessons that utilize assessment items from previously published MCAS assessments that are aligned with their lesson content. Analysis of pre and post assessment data reveal that students taught by participating teachers have demonstrated significant knowledge gains.

VIII. Impact of Supplemental Activities

A. Methods

1. *Participants.* All (100%) of Year 2 teachers and 100% of Year 1 teachers who participated in the project activities participated in the portion of the evaluation designed to assess the impact of the supplemental activities. The evaluation team worked with the science curriculum directors in the districts to identify a matched comparison group of teachers. The team reached out to teachers in the target districts who were teaching science. A total of 17 comparison teachers completed the Post Professional Development Survey.

2. *Design*. The external evaluation team conducted a criteria-based evaluation (Wilson & Onwuegbuzie, 1999). As such, the evaluators analyzed the impact data against the desired benchmarks established by the Leadership Team.

3. *Instruments/Protocols.* The external evaluation team developed Pre and Post Professional Development Surveys, used existing valid and reliable measures including the Reformed Teaching Observation Protocol (RTOP), and developed interview protocols and document review protocols. The Pre and Post Professional Development Survey asked participants about attitudes, knowledge and practices regarding science teaching as well as curriculum/technology integration. The Post Professional Development Survey asked questions about confidence and current practice. It also asked a question about what participants planned to do in the future. The Pre and Post Professional Development Surveys were refined in Year 2 to reflect changes in the supplemental activities. In addition, the evaluation team performed secondary analysis of teacher assessment data that were collected by University of Massachusetts Boston faculty prior to and after completion of each course.

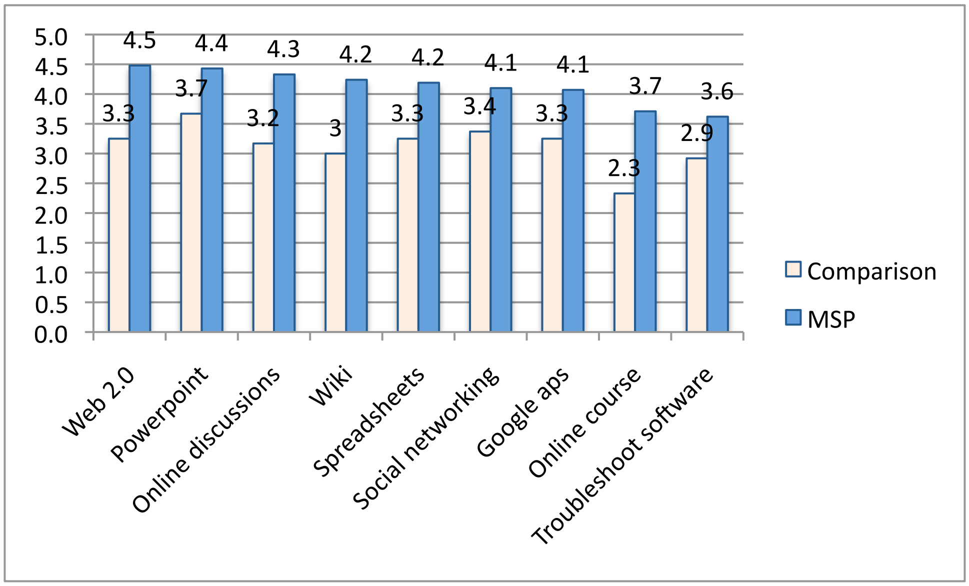
4. *Data Collection Procedures.* The evaluation team collected survey data using SurveyMonkey, reviewed teacher lessons posted to the project's Wiki spaces pages, and obtained a sample of lessons from teachers who volunteered to provide baseline lessons. Finally, document review protocols were used to analyze existing data.

B. Results

1. *Response Rate.* All (100%) of Year 2 participating teachers competed the Post Professional Development Survey and all 17 comparison teachers who were recruited completed the same survey.

2. *Findings.* Analyses of data reveal that teachers who participated in the Year 2 supplementary activities reported significantly higher confidence scores regarding technology than comparison teachers. Graphic 8 below presents items in which the participating teachers demonstrated higher confidence that is statistically significantly *($p<.05$)* higher than comparison teachers on the Post Professional Development Survey.

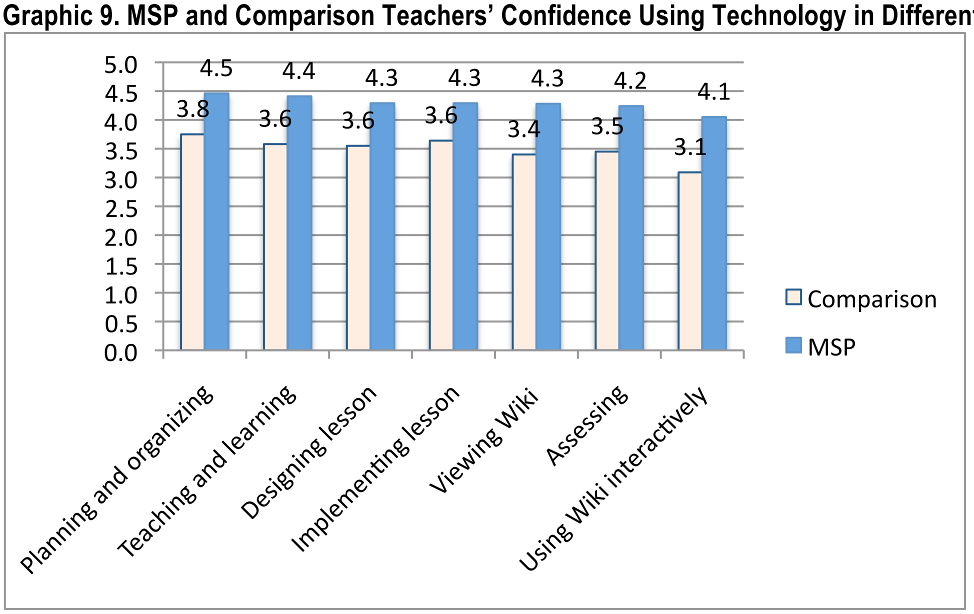
Graphic 8. Year 2 MSP and Comparison Teachers' Confidence with Technology



Average confidence, scale 1=low, 5=high

Year 2 participating teachers reported higher confidence using technology in different ways to support their teaching and their students' learning than comparison teachers. Analysis of Professional Development Survey results revealed that participating teachers reported statistically significant confidence scores on selected items when compared with non-participating teachers *(p<.05)*. These findings are consistent with Year 1 reports from teachers.

Graphic 9. MSP and Comparison Teachers' Confidence Using Technology in Different Ways



Average confidence, 1=low, 5=high

Analysis of Post Professional Development Survey data from Year 1 and Year 2 teachers reveals similar trends in Post Professional Development Survey confidence scores.

As in Year 1, Year 2 teachers reported a range of ways in which they were using technology for teaching and learning. For example, some teachers reported increased knowledge of Web 2.0. Different teachers described the Web 2.0 knowledge they gained. Illustrative quotes are presented below.

> This class enabled me to break the habit of only pen and paper or poster presentations and allow students to complete projects with digital tools of their choice. As much as I was a little afraid of trying something new and how to assess the project... it ended up working great. I am glad I took this class to get the confidence and skills to incorporate Web 2.0 into my classes.[Middle school teacher from Earth Science, high-needs district]

> I have been able to integrate technology using Glogster, Prizi and even simple things like embedding videos/discussions into my classroom that I hadn't done before. [Middle school teacher from Earth Science, suburban district]

> I am using and managing social networking sites for teachers with my 100 students this year (Edmodo.com). I am also using online flashcards, study tools, content review games with my students through Quizlet, which I learned about in this course. [Middle school teacher from Biology course, suburban district]

> I am able to use wiki and glogster.com with confidence now. I am using them in my classroom thanks to this class. [High school teacher from Biology course, high-needs district]

Fewer Year 2 participants suggested changes in the supplemental activities when compared with those who participated in Year 1. Yet two Year 2 teachers reported some challenges that they were experiencing implementing lessons developed through the workshops.

> I understand the benefit of using technology in teaching, especially with this generation of students. There are many conflicts and obstacles with this objective including District policies that restrict the use of social networking. Also, the lack of a strong technology infrastructure in a district can frustrate teachers' intentions to use some computer technologies for the intended efficiencies and benefits.[Middle school teacher from Earth Science course, high-needs district]

> It is a good course, but it takes time for teachers to acquire and adapt technology or new approaches. [Middle school teacher from Earth Science course, high-needs district]

C. Discussion

Overall, the participants viewed the supplemental activities quite favorably. The project changed the timing of the workshops and project staff made refinements to the workshop curriculum based on Year 1 formative findings. Moreover, in Year 2 the Leadership Team address suggestions made by the teachers participating in the first Year 2 course and made further refinements. Changes included adding printable checklist to each workshop, audio introductions to many of the workshops, and embedding how-to videos to the lesson to give the participants multi-modal explanations of how to complete activities. The positive impact of the supplemental activities appears to reflect the refinements based on the use of the formative findings.

IX. Integration of Courses and Activities with District and School Initiatives

A. Methods

1. *Participants*. The Project Director, Teacher Learning Center Directors and the Leadership team participated in activities to support integration of the courses and activities with district and school initiatives.

2. *Design*. The data presented in this section are descriptive.

3. *Instruments/Protocols.* The evaluator used a running record as a method of collecting data from ongoing project meetings.

4. *Data Collection Procedures.* This section was written by the Project Director and the evaluator verified the information by reviewing data collected during ongoing project meetings and reviewing project, district, and school documents.

B. Results

1. *Response Rate.* Not applicable since the data in this section are from a convenience sample.

2. Findings.

The school district science curriculum leaders participated in project meetings and district-based workshops. This ensured that the district and school needs were met, that the districts were aware of project activities, and that project components were integrated into school improvement initiatives and district-based professional development for teachers and administrators.

The district-based Teacher Learning Center Directors offered professional development in the partner districts. The project management team met bi-weekly to review project status and progression of the project work plan. A project Advisory Board including all key project partners met bi-annually to review the performance of project activities.

While the majority of secondary teachers of science, technology and mathematics in this partnership are licensed in the content they teach, K-6 elementary teachers who teach in self-contained classrooms (as well as English Language Learner and special education teachers) hold generalist licenses, and some grade 5 and 6 teachers hold math licenses. In several of the districts there are teachers who are licensed in one area of science but teaching in another.

This project was fully aligned to the major goals found in all of the partnering districts school improvement plans. The science curriculum and administrative leadership in the districts have tremendous interest and commitment in increasing the number of teachers in their districts who advance their content knowledge by participating in high-quality professional development that includes rigorous immersion in science course instruction and curricula, and that assists teachers in learning science through inquiry-based learning experiences so they can transfer these learning strategies to their classrooms.

The project-aligned goals in all the participating school districts include: improving MCAS performance to the proficient or advanced levels; continuously examining and improving work by teachers and administrators to evaluate success based on evidence of student progress; and ensuring that professional development in each school and district focuses on enhancing teaching and learning. Each district has goals that address the key elements of 21st century education, with an emphasis on core academic subjects with a deep understanding of content. As a core academic subject, science content is of great importance to all the districts and their leadership. All the participating districts and schools were actively involved in the planning of this science initiative, and indicated a similar need for this professional development. In addition, the inclusion of science MCAS as a graduation requirement for the public schools increased the immediate need for this professional development content focus.

Several of the partner districts are in the midst of changes in their science curriculum and/or science teaching structure. For example, one district recently changed to a *Physics First* curriculum where all students begin their high school science course of study with Physics. Another district recently changed to having K-8 school building math and science specialists, and another district is shifting towards upper elementary math and science specialists. Prior to this project, Malden was the only district among the partnering districts to offer professional development programs to train teachers in these changing roles, and to ensure they have the science content expertise necessary to enact these teaching changes successfully.

The Teacher Learning Center Directors (TCLDs) attended leadership, curriculum and school-based meetings to introduce teachers and administrators to the project and the available lessons. In addition, the TLCDs have delivered in-district technology professional development and participated as members of district technology committees. The TLCDs will offer additional professional development in the partner districts on utilizing the newly created science lessons placed online upon completion of each year. This bank of available lessons will grow throughout the 3 years of project funding, as teachers complete their inquiry-based lessons and the TLCDs convert these lessons into an online format and place them on the TRITEC server for easy access to all districts.

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HIGHER EDUCATION INTEGRATION

I. Please fill in information below for any **courses** that were incorporated into pre-existing undergraduate, graduate, or continuing education programs. If no courses were incorporated into pre-existing programs, include a statement indicating such.

Incorporated Courses: September 2008-August 2011							
Course Title	**Course Subject** *Math:M Sci/Tech:ST Blended:B*	**When was course first approved as a higher ed offering?** *(Month,Year)*	**Was course developed specific-ally for MMSP?** *Yes or No*	**Names and Departments of Course Developers**	**Course Level** *Undergrad:U Graduate:G Contin Ed:C*	**Number of Credits Course Was Worth**	**Name of College or University and Name of Department into which Course was Integrated**
Biology II – Ecology, Evolution and Diversity of Life	Biology	April 2005	NO	Dr. J. Ebersole, Biology, UMB; Dr. C. Zahopoulos, School of Engineering, NEU	Graduate	3	University of Massachusetts – Boston, Corporate, Continuing and Distance Education; Northeastern University, College of Professional Studies
Earth Science I – Weather & Water	Earth Science	April 2005	NO	Dr. E. Douglas, Earth & Env. Sci, UMB; Dr. C. Zahopoulos, School of Engineering, NEU	Graduate	3	University of Massachusetts – Boston, Corporate, Continuing and Distance Education; Northeastern University, College of Professional Studies

II. Were any new degree programs created based on courses that were developed for your MMSP program? If yes, please specify institution of higher education, degree program, higher education department, and year of program creation. In addition, please indicate how many participants have enrolled in this program to date. If no, please indicate so.

No, no new degree programs were created.

III. If MMSP **course components** (e.g., case studies, assessments, or materials) were utilized in other programs or courses offered through your higher education partner, please provide details below. If no course components were utilized in other programs or courses, include a statement indicating such.

Course Components Used		
MMSP Course from which Components Were Drawn	**Description of Component or Components Used**	**Name of Pre-existing Course or Program into which Components were Incorporated, Including Institutional Affiliation**
Biology II – Ecology, Evolution & Diversity of Life	All components were developed under a National Science Foundation grant in conjunction with the Boston Public Schools Department of Science and the graduate school of Science faculty at University of Massachusetts-Boston and Northeastern University.	Biology II – Ecology, Evolution & Diversity of Life (The BPS/NSF course has the same name, syllabus and course content.)
Earth Science II – The Solid Earth (Earth's History & Planetary Systems)	All components were developed under a National Science Foundation grant in conjunction with the Boston Public Schools Department of Science and the graduate school of Science faculty at University of Massachusetts-Boston and Northeastern University.	Earth Science II – The Solid Earth (Earth's History & Planetary Systems) (The BPS/NSF course has the same name, syllabus and course content.)

APPENDICES

Assessments and data collection instruments are presented in the Appendices. Note: in some instances formatting is lost.

Instruments include:

- Biology Post Teacher Content Knowledge Assessment
- Earth Science Post Teacher Content Knowledge Assessment
- Semi-Structured Interview Protocol
- Reformed Teaching Observation Protocol
- Post Professional Development Survey

Biology 535: Teaching Ecology, Evolution, and the Diversity of Life (2012)

Post-Course Test

Name:___________________________________

Multiple Choice

1. Which of these individuals is most likely to be successful in an evolutionary sense?
    A. A reproductively sterile individual who never falls ill
    B. an organism that dies after 5 days of life but leaves 10 offspring, all of whom survive to reproduce.
    C. A male who mates with 20 females and fathers 1 offspring
    D. an organism that lives 100 years and leave 2 offspring, both of whom survive to reproduce
    E. a female who mates with 20 males and produces 1 offspring

2. In an imaginary world, every 50 years people over 6 feet tall are eliminated from the population. Based on your knowledge of natural selection, you would predict that the average height of the human population will
    A. Remain unchanged.
    B. Gradually decline.
    C. Rapidly decline.
    D. Gradually increase.
    E. Rapidly increase.

3. A controlled experiment is one in which
    A. The experiment is repeated many times to ensure that the results are accurate
    B. The experiment proceeds at a slow pace to guarantee that the scientist can carefully observe all reactions and process all experimental data.
    C. There are at least two groups, one of which does not receive the experimental treatment.
    D. There are at least two groups, one differing from the other by two or more variables.
    E. There is one group for which the scientist controls all variables.

4. Natural selection requires which of the following
    A. Heritable variation within populations
    B. Environmental change
    C. Differential reproductive success
    D. Survival of the fittest
    E. A and C

5. Which statement best describes how the evolution of pesticide resistance occurs in a population of insects?
   A. Individual members of the population slowly adapt to the presence of the chemical by striving to meet the new challenge.
   B. All insects exposed to the insecticide begin to use a formerly silent gene to make a new enzyme that breaks down the insecticide molecules.
   C. Insects observe the behavior of other insects that survive pesticide application and adjust their own behaviors to copy those of the survivors
   D. A number of genetically resistant pesticide survivors reproduce. The next generation of insects contains more genes from the survivors than it does from susceptible individuals.
   E. B and D only

6. In an infinitely large population with random mating and no immigration/emigration, selection, or mutation, the frequency of one of the two alleles at a particular locus is 0.4. What fraction of the individuals will be homozygous for this locus in the next generation?
   A. 0.6
   B. 0.36
   C. 0.52
   D. 1.00
   E. 0.25

7. The origination of new species
   A. usually involves a mutation producing a large effect
   B. always involves a change in the probability of successful mating between individuals in different segments of an ancestral population
   C. may arise from chromosomal multiplication
   D. implies changes in allelic frequencies
   E. b, c, and d are all correct

8. Circle the one that is **incorrect**. Modern evolutionary trees (cladograms)
   A. are hypothetical and predictive
   B. depict sequences of speciation
   C. are based mainly on the total number of equally weighted characteristics shared among living organisms
   D. are based mainly on ancestry
   E. often use DNA sequences

9. If a city of population 10,000 experiences 100 births, 40 deaths, 10 immigrants, and 30 emigrants in the course of a year, what is its net annual percentage growth rate?
   A. 0.4%
   B. 0.8%
   C. 1.0%
   D. 4.0%
   E. 8.0%

10. Circle the one that is **correct**. The existence of a carrying capacity for a population implies:
   A. Predators or parasites are limiting this population.
   B. Some density-dependent factor is acting on either birth rate, or death rate, or both.
   C. Positive feedback between population size and population growth rate.
   D. Sustainable harvest of the population is impossible.
   E. Intra-specific (within-species) competition.

11. Circle the one that is **correct**. Menopause (cessation of female reproduction long before the end of life)
   A. is common among non-human animals
   B. is a by-product of an extended life achieved through careful living or good medical care
   C. is the maladaptive characteristic of species that have escaped the influence of natural selection
   D. is a way to maximize reproductive success in organisms with unusually helpless offspring that require extended parental care
   E. is an important form of sexual selection

12. Circle the **incorrect** answer. Coexisting competing species
   A. may be factors that determine carrying capacity for each other
   B. can never occupy the same ecological niche
   C. must share a resource that is in short supply for both of them
   D. exert selective pressure on each other for wider ecological niches
   E. None of the above are incorrect

13. Predators interacting with prey may:
   A. prevent prey from living in some habitats they otherwise could occupy
   B. allow prey to occupy habitats they otherwise could not inhabit
   C. influence prey social behavior
   D. influence prey appearance
   E. all of the above are correct

14. A newly introduced plant is **less** likely to become "invasive" if:
   A. It is capable of dispersing widely
   B. It is introduced into a highly diverse habitat
   C. It is associated with physically disturbed sites
   D. It has a broad native geographic range
   E. It is a terrestrial, rather than marine, species

15. Which of the following factors is fundamentally responsible for seasons on earth?
   A. Changes in Earth's distance from the Sun
   B. The tilt of Earth's axis of rotation
   C. Ocean currents
   D. Global wind patterns
   E. The greenhouse effect

16. Traveling southward from the Arctic regions of Canada to the tropics of Panama, one passes through several biomes – tundra, coniferous forest, temperate deciduous forest, and tropical rain forest. This pattern of change in vegetation is primarily the result of

A. primary and secondary succession
B. the invasion of exotic species
C. an increase in mean annual temperature and decrease in mean annual precipitation
D. an increase in both mean annual temperature and mean annual precipitation
E. an increase in the total annual hours of sunlight

17. Biomass can be defined as:

A. a unit of evolution
B. the number of organisms on a single trophic level
C. a subdiscipline of biology
D. the total weight of some defined group of living organisms
E. the rate of growth of primary producers

18. Most of the carbon on Earth can be found in:

A. the air
B. the ocean
C. plants and topsoil
D. rocks (includes limestone and other carbonaceous plant/animal remains)
E. animals

19. The molecules of a greenhouse gas:

A. absorb and reradiate ultraviolet light
B. reflect visible light
C. are transparent to electromagnetic radiation
D. reflect gamma rays
E. absorb and reradiate infrared light

20. The niche of a species is:

A. The role of a species in its interactions with other species
B. Its major area of refuge from predators
C. The multi-dimensional space defined by all biological and physic-chemical features that determine where the species can live
D. The space occupied by a population at carrying capacity (K)
E. The habitat occupied by a species at any given point in time

21. An ecosystem is said to be under “top-down” control if:
   A. loss of a primary predator (or “first carnivore”) increases biomass of producers
   B. loss of a primary predator (or “first carnivore”) decreases biomass of producers
   C. loss of a keystone species does not affect other trophic levels
   D. diversity (or “species richness”) of higher trophic levels is greater than that of producers
   E. connectedness of higher trophic levels exceeds that of producers

22. The ultimate source of energy to support most life on Earth is _____.
   A. photosynthetic plants
   B. chemosynthetic microbes
   C. geothermal heat
   D. the carbon cycle
   E. sunlight

23. In evolutionary terms, an organism's fitness is measured by its _____.
   A. health
   B. contribution to the gene pool of the next generation
   C. mutation rate
   D. genetic variability
   E. stability in the face of environmental change

24. An organism's "trophic level" refers to _____.
   A. the rate at which it uses energy
   B. where it lives
   C. what it eats
   D. whether it is early or late in ecological succession
   E. the intensity of its competition with other species

25. Diagrams of numbers or biomass of organisms in ascending trophic levels are usually shaped like pyramids because:
   A. Organisms at each level store most of the energy permanently.
   B. Physiologies become more inefficient at higher trophic levels.
   C. All organisms eventually die.
   D. A substantial fraction of energy at any one level is lost through respiration, defecation, etc.
   E. Secondary consumers are larger than primary consumers, and so on.

26. An ecosystem is unlikely to be limited by the supply of _____ because it is obtained from the air.
    A. water
    B. carbon
    C. phosphorus
    D. calcium
    E. nitrogen

27. Which one of the following processes does **not** increase the concentration of greenhouse gases in the atmosphere?
    A. using coal to generate electricity
    B. increasing the number of cows and sheep to help feed a growing human population
    C. burning tropical rain forests to clear land for grazing
    D. failing to repair leaks in natural gas pipelines
    E. acidification of the oceans

28. Which of the following is a population?
    A. a spider and the fly it is about to eat
    B. all the plants that live near each other in a forest
    C. the earthworms that live in a grassland plus the earthworms that live in a forest
    D. all the coyotes on Earth
    E. all of the redwood trees that live in a forest

29. Factors contributing to high species diversity are:
    A. High productivity
    B. Moderate predation
    C. Easily sub-divided resources
    D. Physical complexity
    E. All of the above

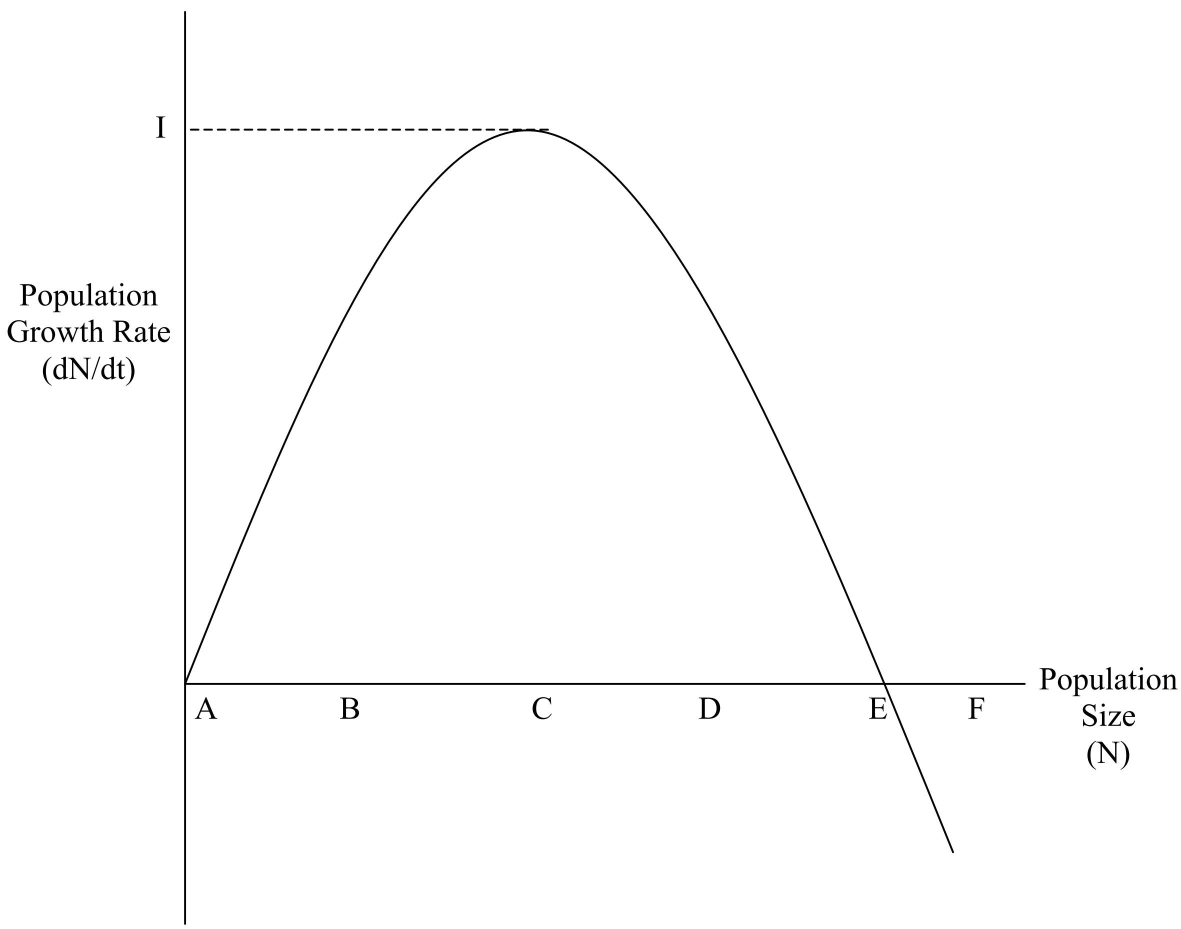
30. The combination of (1) a community of living organism interacting with one another and (2) their abiotic environment is called
    A. A species
    B. An ecosystem
    C. A population
    D. A lithosphere
    E. A niche

CHOOSE ONE QUESTION FROM THE FOLLOWING TWO QUESTIONS. Please keep your answer to this paper.

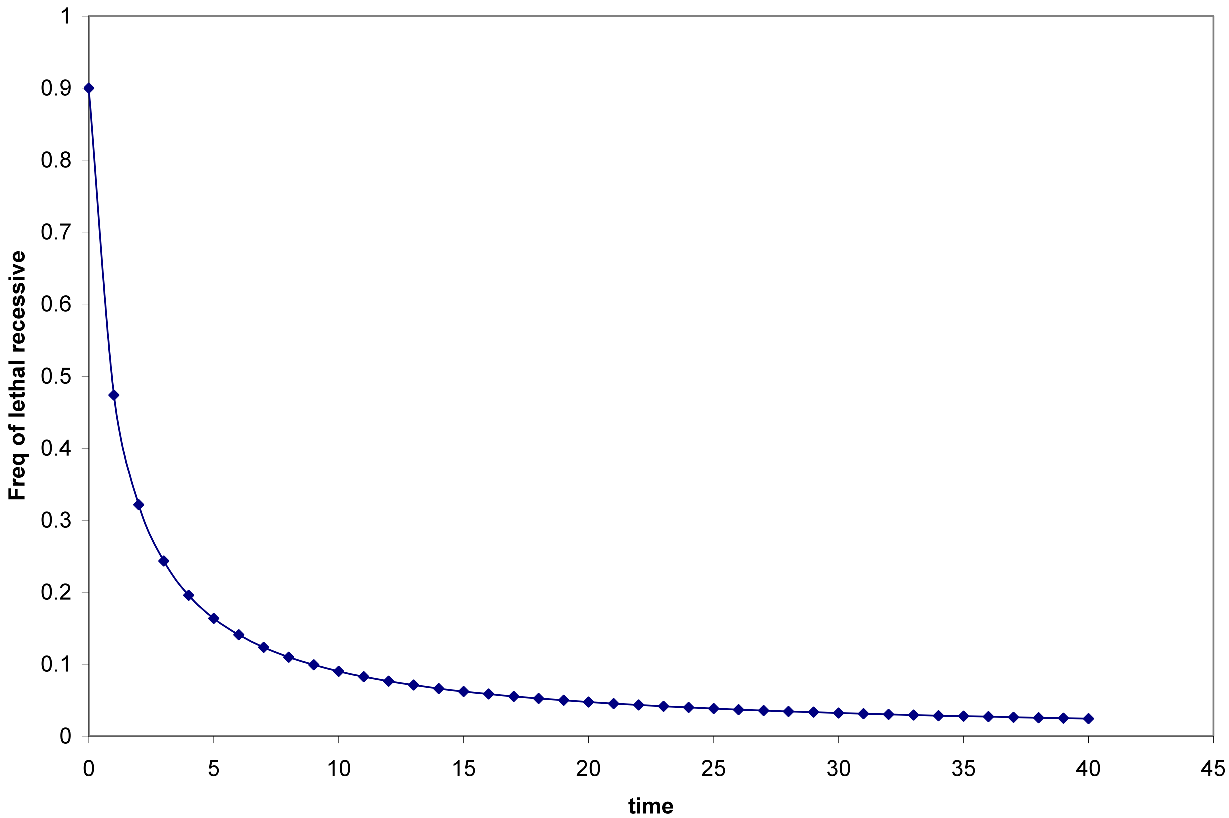
1) Before people started fishing for it, fisheries biologists found that the tasty orange fluffy – a deep-water marine fish from New Zealand – shows logistic population growth in the absence of fishing pressure, as illustrated below in the graph of Population Growth Rate (dN/dt) versus Population Size (N). Despite warnings from fisheries biologists that harvest of the orange fluffy should be no greater the Maximum Sustainable Yield (indicated by the 'I' on the graph below), the New Zealand government allowed an unlimited harvest.

a. What letter on the graph indicates best the population size of the orange fluffy before fishing began? (2 pts)

b. With the population of the orange fluffy at 'B' following a few years of unlimited harvest, the New Zealand government decides to impose a limit; as recommended by the fisheries biologists years earlier, the rate of harvest will be held at 'I'. In one or two sentences, describe what will happen to the orange fluffy populations. Be sure to say **how** it will change and **what** the ultimate outcome will be (4 pts). Express your answer again in a graph of *Population Size* versus *Time* (4 pts). Please put your answer on the back of this page.



2)



The graph above is a plot of allele frequency *versus* time for a recessive allele that predominates in a population (its frequency is roughly 90 % at time 0) until an environmental change occurs at time 0. From this time forward, all individuals homozygous for this allele die before reproducing (that is to say, it is a lethal recessive). On the back of this page, explain why natural selection becomes so ineffective at reducing the frequency of this allele at the far right end of the graph. You may assume that the population is very large, and that mating is completely random, so the Hardy-Weinberg formula accurately indicates the frequencies of genotypes in newly formed zygotes.

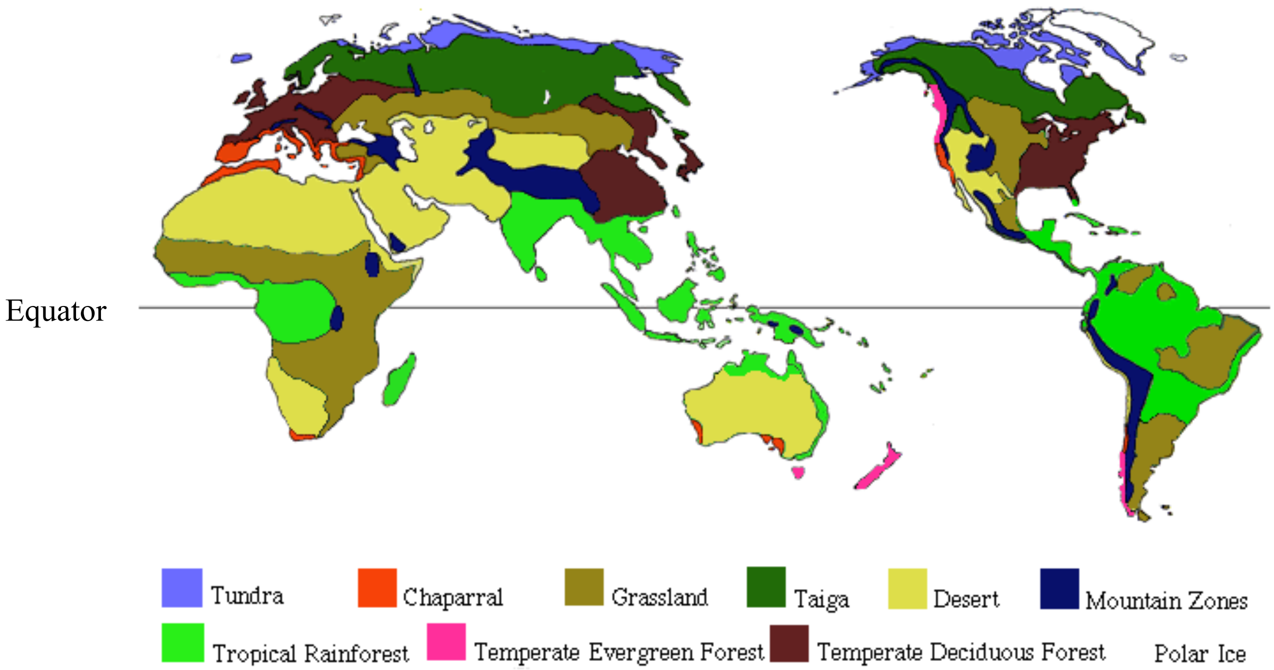
CHOOSE <u>ONE</u> QUESTION FROM THE FOLLOWING TWO QUESTIONS. Please keep your answer to this paper.

3) Use the map below to help answer the following questions.

a. What is a biome?

b. What factors control their distribution (give at least 3 specific details)?

c. Why does the western side of North and South America differ from the western side of Europe and Africa?



4) A recent analysis found that decades of fire suppression had reduced landscape and species diversity in the forests of the northern Rocky Mountains. Explain why, and describe how, a different fire management approach might increase landscape and species diversity.

Pre-Post Test
Earth Science 1

Multiple choice: Please do not write on the exam sheet. Answer all multiple-choice questions on the Scantron sheet.

1. You have 3 L of H2 gas in a balloon and 3 L of O2 gas in another balloon. The balloon with H2 gas floats, while the balloon with O2 gas falls to the ground. Which of the following is NOT true?

    A) Both have the same volume.
    B) Both have the same number of moles.
    C) The O2 balloon has more molecules.
    D) Oxygen gas is more dense than hydrogen gas.

2. When the temperature in degrees Celsius of a sample of air in a balloon is doubled, the volume of the balloon will:

    A) Double
    B) Less than double
    C) More than double
    D) Not enough information

3. At constant temperature, the change of state of any substance from liquid to gas always includes which of the following?

I. The breaking of covalent bonds
II. An increase in the randomness of the system
III. The absorption of energy

    A) I
    B) I and II
    C) II and III
    D) I, II, and III

4. When determining climate change, oxygen isotope measurements are made from an analysis of __________.

    A) cores from old trees
    B) glacial ice
    C) ocean water
    D) lava
    E) none of the above

5. What are the two most abundant gases in the earth's atmosphere?

    A) nitrogen and oxygen
    B) oxygen and carbon monoxide
    C) water vapor and argon
    D) methane and hydrogen

6. The most abundant greenhouse gas in the atmosphere is
   A) carbon dioxide
   B) methane
   C) water vapor
   D) sulfur dioxide

7. The greenhouse gas that traps the most radiant energy per volume is
   A) carbon dioxide
   B) methane
   C) water vapor
   D) sulfur dioxide

8. The greenhouse gas most produced by anthropogenic sources is
   A) carbon dioxide
   B) methane
   C) water vapor
   D) sulfur dioxide

9. What causes a warm, humid mass of air to move (generally) northward?
   A) Magnetic attraction of the air mass toward the north pole.
   B) Differences in surface atmospheric pressure lead to air motion.
   C) The earth's rotation about its axis.
   D) Gravity.

10. Areas of low pressure are typically characterized by ______ air and move toward regions where the pressure is ______ with time.
   A) sinking; falling
   B) rising; falling
   C) sinking; rising
   D) rising; rising

11. Which one of the following is a significant contributor to increased levels of atmospheric carbon dioxide?
   A) Deforestation
   B) Aerosol spray can gases
   C) Refrigerant leakage
   D) Large rice paddies
   E) None of the above

12. Most surface winds in the Tropics:
   A) blow from an easterly direction
   B) originate in the Sahara desert
   C) blow from a westerly direction
   D) originate in the Amazon basin
   E) all of these

13. The key element in the global distributions of heat and cold over the earth's surface is _____________.

A) latitude
B) ocean currents
C) the general global circulation
D) topographic relief
E) all of these

14. The term "front" refers to ___________.

A) the zone of conflict within an air mass
B) the zone of conflict at the contact between two dissimilar air masses
C) the zone of conflict on the eastern edge of an air mass
D) the zone of conflict at the contact between two similar air masses
E) all of these

15. Atmospheric pressure ___________.

A) decreases with height
B) increases with height
C) is caused by an interaction between the earth and the sun
D) is not related to weather systems
E) none of these

16. Which of the following fuels would produce the most CO2 per gallon combusted.

A) Methane (CH4)
B) Propane (C3H8)
C) Ethanol (C2H5OH)
D) Octane (C8H18)

17. As a result of climate change, temperatures in the north are predicted to increase by:

A) 50 degrees Celsius
B) 25 degrees Celsius
C) 7 degrees Celsius
D) 15 degrees Celsius

18. In terms of the carbon cycle, where is the 'missing' carbon released into the atmosphere going?

A) Dissolving in the ocean
B) Absorbed by trees: terrestrial photosynthesis
C) Carbon capture by coal companies
D) None of the above

19. The hottest part of the day is in the afternoon, after the sun has passed its highest point in the sky. The hottest part of the year is in August, after the sun has passed the point where it is highest in the sky for the longest period of time. Why?

A) the suns rays are stronger in the afternoon and in August
B) the earth is closer to the sun during these times
C) the total mass of the earth, water, and atmosphere takes a long time to heat up
D) the angle of the sun's rays during these times

20. Changes in surface atmospheric pressure are best explained by:

A) changes in air density
B) changes in air temperature.
C) changes in atmospheric mass.
D) all of these changes lead to changes in pressure
E) none of the above.

21. The layer of the Earth's atmosphere in which weather occurs is the

A) stratosphere
B) troposphere
C) thermosphere
D) mesosphere

22. Which of the following would have the highest density?

A) Pure water
B) Water with 1 g salt dissolved
C) Water with 5 g salt dissolved
D) Water with 10 g salt dissolved

23. As a gas is cooled,

A) both the volume and the density increase.
B) the volume decreases and the density increases.
C) the volume increases and the density decreases.
D) both the volume and density decrease.

24. What is the mass of the solution when 1 pound of salt is dissolved in 20 pounds of water?
A) 20 pounds
B) Between 20 and 21 pounds
C) 21 pounds
D) 19 pounds
E) More than 21 pounds

25. Argon, which comprises almost 1% of the atmosphere, is approximately 27 times more abundant than CO2, but doesn't contribute to global warming. Which explanation accounts for this fact?
A) Single atoms do not vibrate.
B) Argon's vibrational energy is not excited by infrared radiation.
C) The mass of argon does not allow it to reach sufficiently high in the atmosphere to interact with the earth's radiant energy.
D) Argon is transparent to UV radiation

26. Liquid water can store more heat energy than an equal amount of any other naturally occurring substance because liquid water
A) covers 71% of Earth's surface
B) has its greatest density at 4°C
C) has the higher specific heat
D) can be changed into a solid or a gas

27. The density of liquid water is 1.0 gm/mL. The density of ice is closest to
A) 1.0 gm/mL
B) 0.92 gm/mL
C) 0.70 gm/mL
D) 1.1 gm/mL

28. Two ice cubes are floating in water. After the ice melts, will the water level be
A) higher
B) lower
C) the same
D) not enough information to answer

29. What is the reason for your answer to the previous question?
A) The weight of water displaced is equal to the weight of the ice.
B) Water is more dense in its solid form (ice).
C) Water molecules displace more volume than ice molecules.
D) The water from the ice melting changes the water level.
E) When ice melts, its molecules expand.

30. Why does an ice cube float in water?
- A) because the air bubbles in the ice make it lighter
- B) because ice is a solid and water is a liquid
- C) because ice has a lower density
- D) because ice is packed tighter than water

31. In the northern hemisphere, it is cold in the winter between December and March because
- A) The sun radiates less energy during this period
- B) Greater distance between the Earth and the sun
- C) The tilt of the Earth on its axis is away from the sun
- D) Interactions with the moon cools down the hemisphere

32. A glass of cold milk sometimes forms a coat of water on the outside of the glass (Often referred to as 'sweat'). How does most of the water get there?
- A) Water evaporates from the milk and condenses on the outside of the glass.
- B) The glass acts like a semi-permeable membrane and allows the water to pass, but not the milk.
- C) Water vapor condenses from the air.
- D) The coldness causes oxygen and hydrogen from the air combine on the glass forming water.

33. The circle on the left shows a magnified view of a very small portion of liquid water in a closed container. What would the magnified view show after the water evaporates?

34. When a solution is boiling its average temperature is…
- A) Increasing
- B) Decreasing
- C) Equal to the temperature of the surroundings
- D) Not changing

35. On average, what percentage of the Earth's atmosphere by volume consists of carbon dioxide?
- A) 10%
- B) 4%
- C) 0.4%
- D) 0.04%
- E) 0.00001%

36. Which country is currently the top global emitter of carbon dioxide?
A) United States
B) Brazil
C) China
D) Japan
E) India

37. The term 'albedo' refers to what property of a surface?
A) How long it takes to warm or cool
B) Its ability to reflect radiation
C) How quickly air flows over it
D) The amount of carbon dioxide it can absorb
E) The amount of cover with foliage

38. How many pounds of CO_2 are produced from burning one gallon of gasoline?
A) About 5 pounds
B) About 10 pounds
C) About 20 pounds
D) About 50 pounds

39. When carbon dioxide gas dissolves in water, the pH of the water
A) Decreases
B) Increases
C) Remains the same
D) Decreases, then returns to exactly 7

40. What is a portion of air called that has a uniform temperature and humidity?
A) Warm Front
B) Cold Front
C) Air Mass
D) Stagnant Atmosphere

41. Which of the following allows heat to be released into the upper atmosphere?
A) Lightning
B) Hurricane
C) Nor-Easter
D) High humidity

42. Current weather is a light drizzle, and then it stopped and turned into hot and humid. What must have just happened?
A) A warm front passed through.
B) A cold front passed through.
C) An occluded front passed through.
D) A humidity front passed through.

Short answer: Please respond to each question in no more than one paragraph.

1. What impact is the rising CO2 concentration having on Earth's oceans? Respond in Claims, Evidence, Reasoning format.
2. Explain what causes local winds. Specifically, you may describe one type of local wind, such as a land breeze or sea breeze.
3. Interpret the information provided on this weather map and what it means for the upcoming weather of the Northeast United States.
4. Explain why a piece of wood floats and a rock sinks?
5. What is the role of greenhouse gases in our atmosphere?

Teacher Interview

*You are being asked to participate in an evaluation of the Collaborating to Create a Science Community Project. The evaluation is designed to assess and improve the effectiveness of project activities. All information collected will remain **COMPLETELY CONFIDENTIAL**—data only be seen by the evaluators the results will only be reported in summary form. The evaluation is focused on the project and is not in any way evaluating individual participants. Although you are not required to participate, the state Department of Elementary and Secondary Education asks that each project receiving funding do its best to obtain information from all individuals involved. You may stop participation at any time. If you have any questions, you can contact Diane Schilder, Principal Investigator at 617-816-2026.*

School demographics:

Name:
School:
Title:
Years teaching in general/teaching science/ at this school:
Classes you currently teach:
Number of students you currently teach:

Involvement in project activities

1. What do you know about the project?

2. Why did you become involved?

3. Now I would like to ask specifically about your involvement in course(s). Can you tell me the courses you have taken through the partnership?

4. What is your understanding of the purpose of the courses?

Your science teaching

1. I'd like to ask some questions about your teaching. Can you tell me about your own teaching?

2. What ideas guide your teaching? How, if at all, has the course impacted you and your teaching approaches? (Weave this probes below
    a. Describe your teaching methods (i.e. lecture or inquiry approaches, materials, use of assessment data, etc)
    b. Give me an example of a successful teaching experience you have had in which you have incorporated the approaches or content you learned through the course
    c. Why do you think that was successful?
    d. Can you email me a lesson plan or syllabus that demonstrates incorporation of content or approaches you learned from the course?

    e. Why does that stand out for you?

3. Can you tell me how you are applying the content you learned in the course to your own teaching?

4. How do you know when your students are learning? How do you believe your participation in the course has affected/will affect students' interest in science?

5. From what you know of the project, talk about how you will know whether the project has been successful?

6. Now I'd like to hear about the lesson you developed. Can you tell me about it?

7. Do you have suggestions for improvements in the future? What are the benefits and challenges from your perspective?

8. Is there anything else you would like to add?

RTOP. Source: Piburn, M., & and Sawada, D., (2000). ACEPT Technical Report No. IN00-3, Arizona Collaborative for Excellence in Teacher Preparation.

Appendix II

Reformed Teaching Observation Protocol (RTOP)

Daiyo Sawada, External Evaluator

Michael Piburn, Internal Evaluator

and

Kathleen Falconer, Jeff Turley, Russell Benford and Irene Bloom

Evaluation Facilitation Group (EFG)

Technical Report No. IN00-1

Arizona Collaborative for Excellence in the Preparation of Teachers

Arizona State University

I. BACKGROUND INFORMATION

Name of teacher ______________ Announced Observation? ______________ (yes, no, or explain)

Location of class ______________ (district, school, room)

Years of Teaching ______________ Teaching Certification ______________ (K-8 or 7-12)

Subject observed ______________ Grade level ______________

Observer ______________ Date of observation ______________

Start time ______________ End time ______________

II. CONTEXTUAL BACKGROUND AND ACTIVITIES

In the space provided below please give a brief description of the lesson observed, the classroom setting in which the lesson took place (space, seating arrangements, etc.), and any relevant details about the students (number, gender, ethnicity) and teacher that you think are important. Use diagrams if they seem appropriate.

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III. LESSON DESIGN AND IMPLEMENTATION

		Never Occurred				Very Descriptive
1)	The instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.	0	1	2	3	4
2)	The lesson was designed to engage students as members of a learning community.	0	1	2	3	4
3)	In this lesson, student exploration preceded formal presentation.	0	1	2	3	4
4)	This lesson encouraged students to seek and value alternative modes of investigation or of problem solving.	0	1	2	3	4
5)	The focus and direction of the lesson was often determined by ideas originating with students.	0	1	2	3	4

IV. CONTENT

6)	The lesson involved fundamental concepts of the subject.	0	1	2	3	4
7)	The lesson promoted strongly coherent conceptual understanding.	0	1	2	3	4
8)	The teacher had a solid grasp of the subject matter content inherent in the lesson.	0	1	2	3	4
9)	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged when it was important to do so.	0	1	2	3	4
10)	Connections with other content disciplines and/or real world phenomena were explored and valued.	0	1	2	3	4

Procedural Knowledge

11)	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.	0	1	2	3	4
12)	Students made predictions, estimations and/or hypotheses and devised means for testing them.	0	1	2	3	4
13)	Students were actively engaged in thought-provoking activity that often involved the critical assessment of procedures.	0	1	2	3	4
14)	Students were reflective about their learning.	0	1	2	3	4
15)	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.	0	1	2	3	4

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Propositional knowledge

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15)	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.	0	1	2	3	4

V. CLASSROOM CULTURE

Communicative Interactions		Never Occurred				Very Descriptive
16)	Students were involved in the communication of their ideas to others using a variety of means and media.	0	1	2	3	4
17)	The teacher's questions triggered divergent modes of thinking.	0	1	2	3	4
18)	There was a high proportion of student talk and a significant amount of it occurred between and among students.	0	1	2	3	4
19)	Student questions and comments often determined the focus and direction of classroom discourse.	0	1	2	3	4
20)	There was a climate of respect for what others had to say.	0	1	2	3	4

Student/Teacher Relationships

21)	Active participation of students was encouraged and valued.	0	1	2	3	4
22)	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.	0	1	2	3	4
23)	In general the teacher was patient with students.	0	1	2	3	4
24)	The teacher acted as a resource person, working to support and enhance student investigations.	0	1	2	3	4
25)	The metaphor "teacher as listener" was very characteristic of this classroom.	0	1	2	3	4

Additional comments you may wish to make about this lesson.

Post Professional Development Survey

Disclosure

Tritec and University of Massachusetts Boston received a grant from the Massachusetts Department of Elementary and Secondary Education to offer teachers science courses and related professional development.

The project hired an independent evaluation firm, EAS, Inc, to evaluate the project to provide information to leaders to make improvements and to document the impact of activities on participants. All evaluation data are confidential. Participation in the project is entirely voluntary. For participants who chose to participate, we ask that each individual complete evaluation materials. Please contact Diane Schilder at 617-816-2026 if you have any questions about participation in the project.

Please click on the box below if you have read the information above and agree to complete the survey.

○ I have read the information and agree to complete the survey

Pedagogy

How often do you teach science using the following approaches *to teach science*?

	Daily	5-6 times a week	2-4 times a week	1 time a week	Less than 1 time a week	I don't know what this is
Lectures	☐	☐	☐	☐	☐	☐
Worksheets	☐	☐	☐	☐	☐	☐
Text books	☐	☐	☐	☐	☐	☐
Hands on labs	☐	☐	☐	☐	☐	☐
Inquiry based approaches	☐	☐	☐	☐	☐	☐
Teacher focused lessons	☐	☐	☐	☐	☐	☐
Student driven approaches	☐	☐	☐	☐	☐	☐
Online information sharing and collaboration tools (such as Blogs or social networking)	☐	☐	☐	☐	☐	☐
Online information sharing and collaboration tools that I developed (such as Blogs or social networking)	☐	☐	☐	☐	☐	☐
Online information sharing and collaboration tools that my students develop (such as Blogs or social networking)	☐	☐	☐	☐	☐	☐
Use of mobile devices (such as a smart phone) to support student learning	☐	☐	☐	☐	☐	☐

Technology

I can use the following technology easily, without assistance:

	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	I do not know what this is
Email (including uploading and downloading attachments)	☐	☐	☐	☐	☐	☐
Word processing to prepare documents (including using tables and embedding graphics)	☐	☐	☐	☐	☐	☐
Browsers such as Explorer or Firefox (including opening multiple tabs or browsers)	☐	☐	☐	☐	☐	☐
Saving urls (by using bookmarks or copying urls)	☐	☐	☐	☐	☐	☐
Spreadsheet software such as Excel (including formulas)	☐	☐	☐	☐	☐	☐
Presentation software such as Powerpoint (including embedding videos and sounds)	☐	☐	☐	☐	☐	☐
Social networking sites such as Facebook (including uploading photos and embedding links)	☐	☐	☐	☐	☐	☐
Online course management software such as Moodle or Blackboard (including uploading and downloading)	☐	☐	☐	☐	☐	☐
Wikis	☐	☐	☐	☐	☐	☐
Blogging	☐	☐	☐	☐	☐	☐
Google aps (such as Google docs)	☐	☐	☐	☐	☐	☐
Knowing the difference between Web 1.0 and Web 2.0	☐	☐	☐	☐	☐	☐
Searching online for resources	☐	☐	☐	☐	☐	☐
Troubleshooting software problems	☐	☐	☐	☐	☐	☐
Troubleshooting hardware problems	☐	☐	☐	☐	☐	☐
Using an online discussion forum	☐	☐	☐	☐	☐	☐

How confident are you teaching using the following to *teach science*?

	Very confident	Confident	Neutral	Not confident	Not at all confident	I don't know what this is
Lectures	☐	☐	☐	☐	☐	☐
Worksheets	☐	☐	☐	☐	☐	☐
Text books	☐	☐	☐	☐	☐	☐
Hands on labs	☐	☐	☐	☐	☐	☐
Inquiry based approaches	☐	☐	☐	☐	☐	☐
Teacher focused lessons	☐	☐	☐	☐	☐	☐
Student driven approaches	☐	☐	☐	☐	☐	☐
Online information sharing and collaboration tools (such as Blogs or social networking)	☐	☐	☐	☐	☐	☐
Online information sharing and collaboration tools that I developed (such as Blogs or social networking)	☐	☐	☐	☐	☐	☐
Online information sharing and collaboration tools that my students develop (such as Blogs or social networking)	☐	☐	☐	☐	☐	☐
Use of mobile devices to support student learning	☐	☐	☐	☐	☐	☐

About the Course

Please describe the key earth science topics, ideas or concepts that you understand better as a result of attending this course.

Please describe the key technology or Web 2.0 topics, ideas or concepts that you understand better as a result of attending this course.

Please describe 2- 4 pedagogical approaches and strategies for *teaching science* that you learned in this course.

About the Course

Please indicate whether you agree or disagree with the following statements.

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
a. I will use the content from the course in my science teaching					
b. I will use the pedagogical strategies modeled in this course in my teaching					
c. The course had a positive impact on me as a teacher					
d. My students will benefit from what I learned in this course					

Indicate your level of agreement with the following statements:

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
a. It offered a good balance of content, scientific process, and teaching strategies					
b. There was coherence between the different aspects of the course					
c. Instructors modeled good teaching practices					
d. It demonstrated good planning and organization					
e. There were clear objectives, expectations and goals					
f. There were positive working relationships between the instructors					
g. Instructional team demonstrated expertise					
h. Instructors supported participant learning					